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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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SESSION 1916-17
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The University of Sheffield.

SESSION 1916-17.

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University of Manchester.

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SESSION 1916-1917.

COMMENCING 25th SEPTEMBER, 1916.

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T. MORRISON,
Secretary.

Secretary's Office,
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24th August, 1916. E 956

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30th August, 1916. E 901

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with practical experience of Nitric Acid, Sulphuric Acid Concentrating, Acid Mixing and Denitrating Plants. Must be good mechanical engineer, with some knowledge of Electrical Plant, and capable of handling men with tact. Please state age and full particulars of experience. Applications can be made in writing through your nearest LABOUR EXCHANGE, mentioning this Journal and E 963. No person engaged on Government work will be employed.

Wanted, by Firm of Manu-

facturing Engineers, Practical CHEMICAL ENGINEER, with drawing office experience in the design of distilling apparatus and various chemical plant. No person already engaged on Government work will be employed.—Apply, stating age, experience, salary required, to nearest LABOUR EXCHANGE, mentioning this Journal and E 906.

Cold Storage, Refrigerating

ENGINEER REQUIRED for abroad. Apply with copies of testimonials, state age, if married, details of experience and salary required; must be ineligible for Army. No one already engaged on Government work need apply.—Apply, to "T." BOX, 775, T. B. BROWNE'S Advertising Offices, 163, Queen Victoria Street, E.C. E 711

Wanted, Engineer (Ineligible

for Military Service), for Gas Engine and Suction Plant. Knowledge of electricity essential. Permanency to suitable man.—Address, CO-OPERATIVE SOCIETY, 65, Sunbridge Road Bradford. E 970

Wanted, for Large Steel

works near Glasgow, an ASSISTANT to the Chief Engineer.—Apply, to your nearest LABOUR EXCHANGE, stating qualifications and experience, mentioning this Journal and E 985. No one already on Government work need apply.

Required, by a Firm of Con-

sulting Engineers, ASSISTANT ENGINEER. Duties to be fulfilled include acting as Resident Engineer on the Construction of Power Stations, Boiler Houses, Buildings, Foundations and all forms of Mechanical and Electrical Engineering Work, also carrying out of Tests on Plants at Makers' Works and during operation on site.

Applicants should apply, giving particulars of their education, technical training, any diplomas they may have been awarded, and their engineering experience in practice. They should also state their age, whether married, and, if under military age, the reasons for exemption from service.

Salary offered £200 for the first twelve months, with an increase of £25 for the second and third respectively in the event of the applicant proving suitable, in which case the situation would become of a permanent character.

Please address replies to
E 918, Offices of ENGINEERING.

Young Engineer with Draw-

ing Office experience, ineligible, REQUIRED for North London. One accustomed to general factory work. Give fullest particulars, with salary required. No one employed on Government work will be engaged.—Apply, nearest LABOUR EXCHANGE, mentioning this Journal and E 972.

Wanted, by Government

Department, Reliable and Energetic INSPECTORS. Professional experience in automobile work essential. Only those not already engaged on Government work and within 12 miles of London need apply. Please state age. Applications by letter, to:—
D. M. M. T.,
117, Piccadilly. E 908

Wanted, by Government

Department, TECHNICAL ASSISTANT. Sound engineering training essential, with some automobile experience. Only those not already engaged on Government work and within 12 miles of London need apply. Please state age. Applications by letter, to:—
D. M. M. T.,
117, Piccadilly. E 909

Wanted, Assistant Cost and

ESTIMATING CLERK for large Engineering Works. No one already engaged on Government work will be engaged.—Apply, stating age, experience, and salary required to the nearest LABOUR EXCHANGE, mentioning this Journal and E 964.

Draughtsmen (Two) Required

immediately, used to heavy Petrol Engine details. No application will be considered from anyone already employed on Government work or residing outside the 10 miles radius.—Apply in first case, giving full particulars of experience and salary required, to E 981, Offices of ENGINEERING.

Plant Draughtsmen

REQUIRED for immediate Government work. Good experience of general engineering and structural work essential. No man on Government work can be engaged.—Write or apply in first instance to your nearest BOARD OF TRADE LABOUR EXCHANGE, mentioning this paper and E 983.

THE ARRANGEMENTS OF MACHINE SHOPS.—No. III.

By JOSEPH HORNER.

We give on the present page in Fig. 18 a view of the machine shop of Messrs. A. Ransome and Co., Limited, of Newark-on-Trent, this view being taken from one end of the main bay. We further give on page 192, in Fig. 19, a plan showing the arrangement of tools, this plan including the central and the side bays. The machines are operated from two lines of main shafting (Fig. 19) which are divided into two lengths to suit machine groupings. They are driven on one side of the shop by two 40-h.p. motors and on the other side by three of 40 h.p. The machines in the centre bay (Fig. 18) are served by two overhead electric travelling cranes, one being of 5 tons, the other of 3 tons capacity. These are supplemented by jib cranes for the heavier machines. It may be mentioned that the fitting shop, not illustrated, is a continuation of the main bay of this building, and is served by a 10-ton overhead travelling crane.

The machines in this shop are examples of a general rather than of a special character. Although the work of the firm is specialised in wood-working machinery, yet the nature of the operations required is not narrowed as are those, for example, in a shop which handles a product of nearly uniform dimensions, and of a highly repetitive kind. Wood-working machinery includes castings in a large range of dimensions and outlines, but relatively few very special pieces. Consequently we note that the machines which predominate are lathes, planers, shapers and boring machines. Gear-cutters and grinders are a secondary portion of the equipment. A large marking-off table supported on brick pillars is included. The shop floors are provided with tracks and turntables which connect the three bays and serve all the machines. The heavy machines are covered by the overhead cranes in the central bay, supplemented by the jib cranes; the light ones, comprising lathes chiefly, are ranged along the walls of the side bays. Gap lathes and screw-cutting lathes largely exceed in numbers any other single groups of machines, as there is a large quantity of shaft and spindle turning done. There are several turret lathes in the upper bay, and a few gear-cutting, milling and grinding machines. Boring lathes and boring and turning machines and drills are represented. Shaping machines are grouped near one end, and slotting machines adjacent in the main bay. Heavy planers and shapers occupy a large portion of one side of the central area. Some are of very large dimensions to deal with the tables of deal frames, circular saws, and the faces of band-sawing and other frames.

The ridge roof (Fig. 18) is provided with continuous skylights. Similar illumination is afforded to the side shops. Windows in the walls are included. Arc lamps suspended from brackets on the columns provide the artificial supply. If suspended in the roof above the travellers they would have been situated too high, besides which the movements of the travellers would cast shadows. Being suspended from the columns they hang below the travellers and clear of them, and they also illuminate the side bays.

A shop of a different character is that of the Corona Machine Tool Works of Messrs. Frederick Pollard and Co., Limited, of Leicester, illustrated by the section and plan, Figs. 20 and 21, on page 193. This firm is engaged in the manufacture of one class of machine tool only—drilling machines. Although this work is all of a light character, the shops are located on a ground floor in preference to a storied building. They occupy an unobstructed area, covered by saw-tooth roofing, of steel, of comparatively narrow spans, which divide the width into eight bays. The roof is carried on cast-iron columns.

The materials come in over the weighing machine from St. Saviour's Road, East, and are discharged from the "loading dock" to the Nottingham Road at the other end of the building. The various offices are situated at the entrance end of the works. The stock-room for small tools lies adjacent, and also the stores for raw castings.

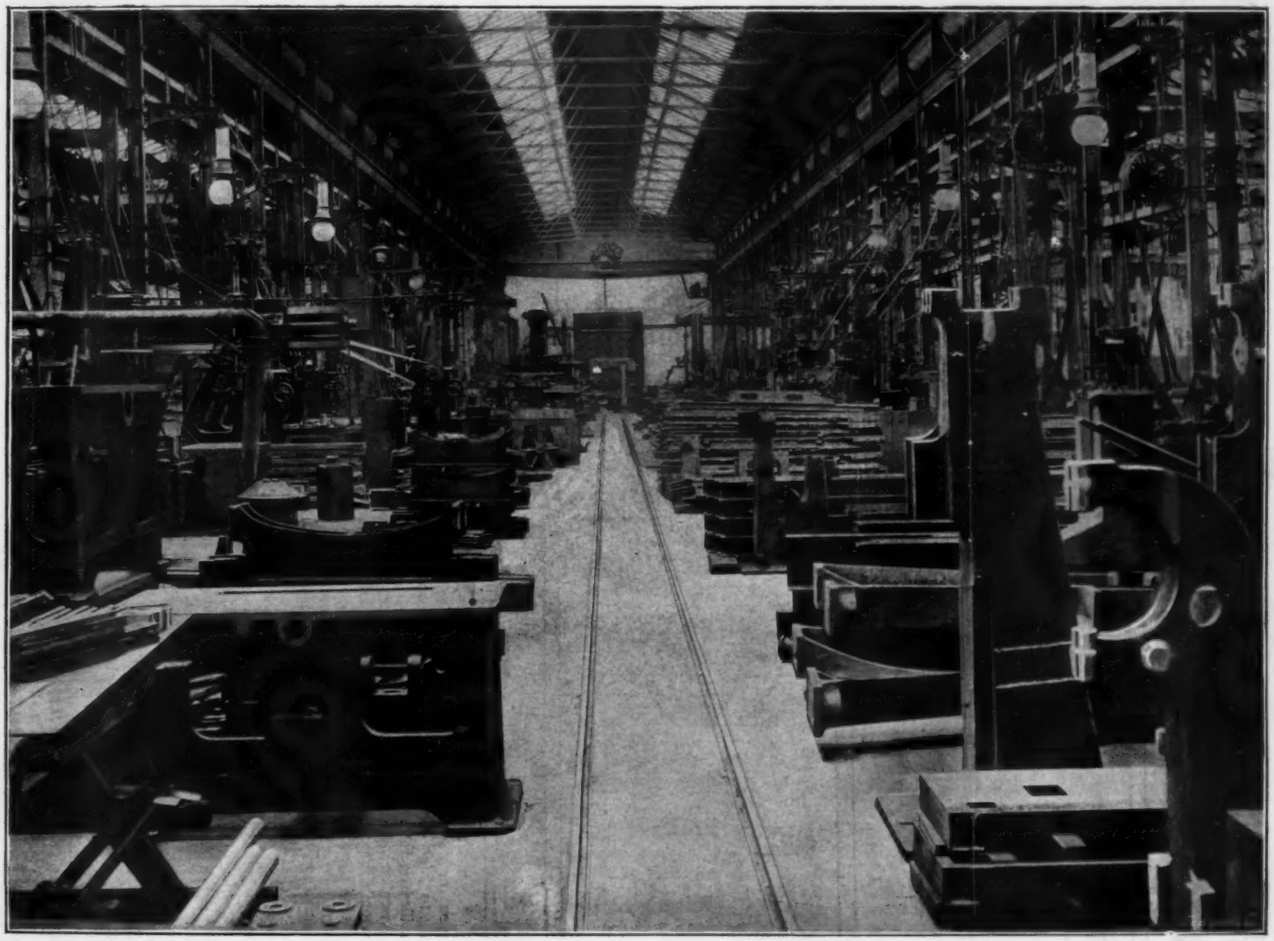
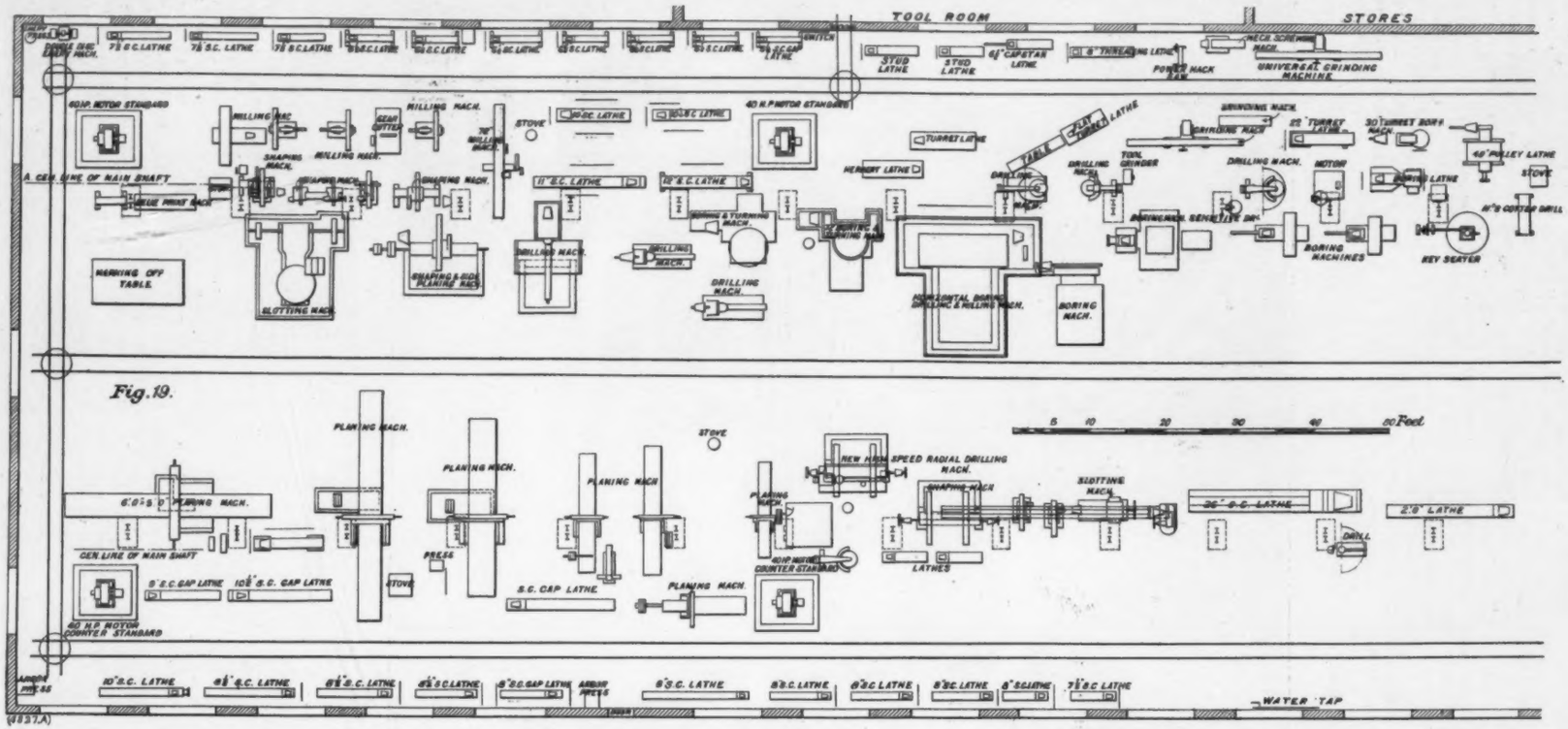


FIG. 18. MAIN BAY OF MACHINE SHOP OF MESSRS. ALLEN RANSOME AND CO., LIMITED, NEWARK-ON-TRENT.

The lay-out of the tool groups in the machine shop is indicated, without isolating the separate machines. Each group occupies its own area, but without any isolation beyond that of clear spaces from the others. The tool-makers' room, with the small-tool stores and the manager's office, are enclosed from the shop. The inspection department is located at the end of the machine shop adjacent to the erecting shop. An equipment of drilling machines, lathes and grinders is furnished for the tool-room. Benches occupy central areas and are ranged round the walls of the shop. A small hardening room is walled off in this department. An extension of the building to the left is occupied by the painting and packing department and the pattern shop.

The basement underneath the general offices, partly below the level of the road, is occupied with hack-sawing machines, straightening presses and centreing machines, racks for steel, and bins for finished parts. Above the general offices and under

PLAN OF MACHINE SHOP OF MESSRS. A. RANSOME AND CO., LIMITED, NEWARK-ON-TRENT.



the roof, the drawing offices and printing room, and the mess-room are located. Hoists and stairs connect the floors.

The scheme of driving is shown in the sectional view of the shops (Fig. 20). The line shafts are all motor-driven, the motors being located on floors or walls. The floor motors are seen in the ground plan. All the shafts have roller bearings. Each motor with its line of shafting can be put in or out of action independently of the others by its own starter. The shop floor is of maple, bedded on a thickness of concrete. Overhead runways cover nearly the whole of the floor.

The two shops illustrated and referred to above, both entirely modern in their lay-out and arrangements, represent two types suited respectively to a rather general, and a very special class of product. They suggest some broad considerations which concern both tool equipment and the buildings of machine shops.

The equipment of any machine shop is dominated by its output. Special machines, a multiplication of machines, the elaboration of jigs and fixtures, are only justified by a correspondingly large product, present or prospective. If there is practically no limit to this there is no limit to the outlay which is justified on the machines and appliances.

Associated with the equipment of machines is the economic importance of avoiding periods of idleness. To keep every machine always occupied, and fully, is one of the problems of good management. An idle tool is a *bête noir* in a shop. This is one of the objections to the installation of those of a highly specialised character in shops where the volume of specialised work is insufficient to keep them fully occupied. It seems preferable then to utilise the standard designs, and to get the best possible from them by the help of special attachments. This, by the way, has been done extensively during the rush for shells. Common lathes and drilling machines have been pressed largely into service, tools which will be equally valuable after the demand for munitions has ceased.

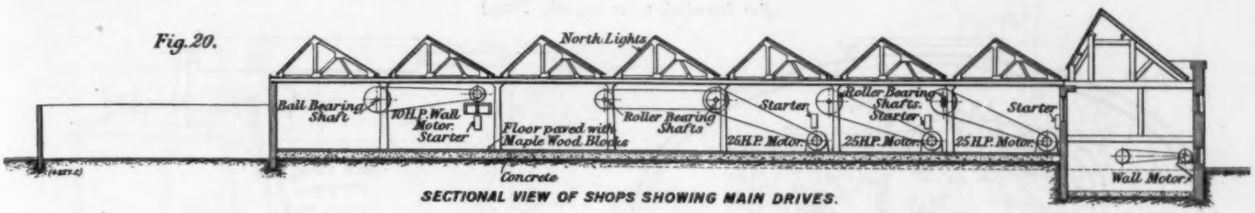
In avoiding the waste of time that is involved in the standing idle of machines, the problem of other alternative methods of tooling occupies a large place in the minds of the management. And thus it happens not at all infrequently that work will be sent to one machine or group of machines other than the regulation ones in order to prevent such tools from standing idly by, and to relieve the ordinary machines from over-congestion. Thus, boring or drilling may occasionally be done in lathes instead of in the regular boring and drilling machines. Vertical and horizontal machines may interchange tasks in turning and facing, or boring. A universal machine may be doing work on which a plain machine would be ordinarily engaged, milling may be substituted for planing or shaping and *vice versa*. The great cardinal fact is that the work is done without time being lost on idle machines.

The construction of the shops has been influenced directly and indirectly by new ideals, and the general abandonment of an archaic practice. They may not cost less to build than their predecessors did, but the money is spent to better advantage. The old shops were always built solidly of stone masonry or brickwork, because they had to sustain the loads of the roof, of heavy travelling cranes, and of wall cranes with their maximum loads, often, too, of radial drilling machines and of wall planers. The stout walls were reinforced with buttresses to carry these eccentric loadings. Such are rarely built now. The most substantial usually is one of one-brick thick. Little or no load is imposed on this; the principal loads are carried on the columns or stanchions. The advantages secured are numerous and undoubted. These columns have passed through stages of development from cast-iron to wrought-iron and to mild open-hearth steel, the material now chiefly used to the practical exclusion of the others.

Cast-iron cylindrical columns, or those of H-section to provide flat faces, gave place to rolled joists of wrought-iron, and then these to rolled steel sections, combinations of which can be made up to suit all conceivable requirements. The disposition of the material is made with the strictest regard to the due correspondence of stresses and strengths, with provisions for eccentric loading when desirable. The books of the steel-makers show many alternatives in the building up of standardised sections to suit all requirements. These columns, simple or composite, block the shop less than masonry walls and piers do, and they may be spaced farther apart, using suitable bracing. A very great subsidiary advantage of their employment is afforded by the

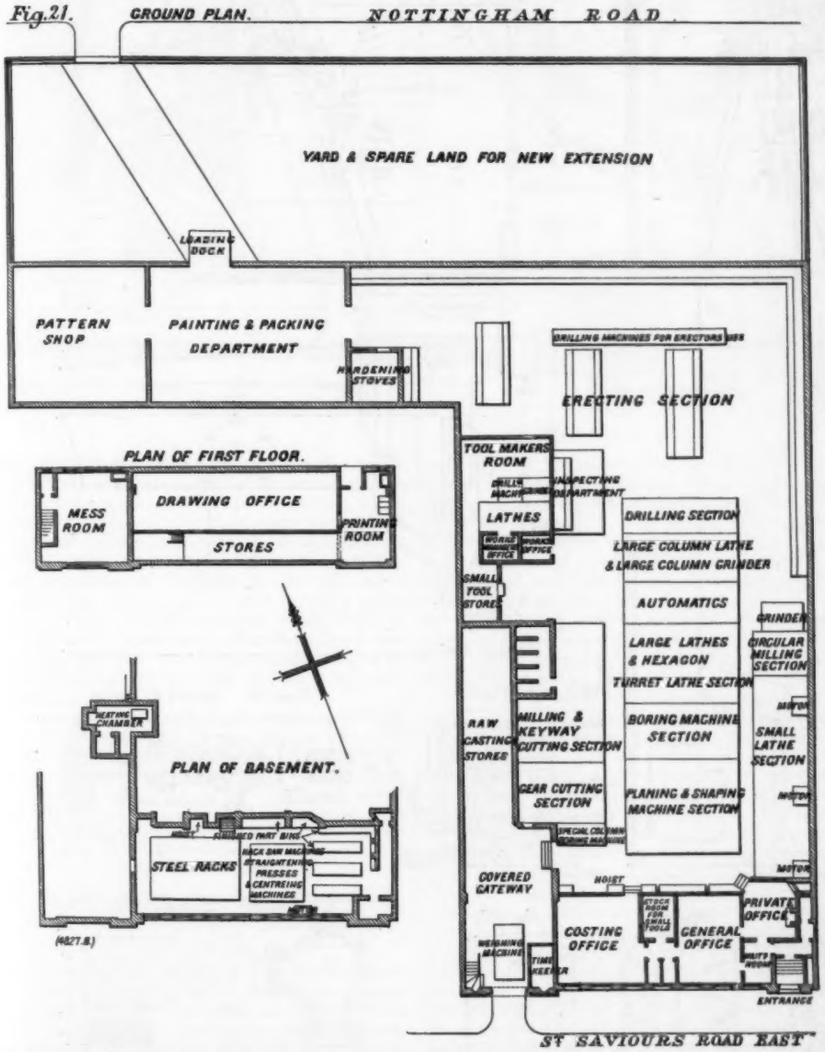
MACHINE SHOP OF MESSRS. FREDERICK POLLARD AND COMPANY LTD.

Fig. 20.



SECTIONAL VIEW OF SHOPS SHOWING MAIN DRIVES.

Fig. 21. GROUND PLAN. NOTTINGHAM ROAD.



flat faces of the rolled joists and channels which serve for the attachments of machines, of jib cranes, and of bracing. When cast-iron cylindrical columns are used, these have flat facings for their attachments cast on, but as their location is fixed they cannot be altered when circumstances render some changes desirable. The only alternative is to bolt saddle plates on. Also steel-plated brackets can be riveted or bolted up anywhere to the steel-built columns, to carry shaft or countershaft bearings. The custom also is not to run the maximum section up to the roof principals, but only as high as the crane gantry, using a smaller section up to the roof, which the columns alone support.

In transferring the stresses from shop walls to columns of steel it is necessary to connect the columns with bracing. Its character depends on the functions which it has to perform. In some cases it is set diagonally between the columns. But the gantry girders are frequently sufficient tie to serve the purpose when the cranes are not very heavy. Above these the upper smaller pillars are united by horizontal girders, which may be plain rolled joists, or light lattice-braced girders. In the transverse direction the roof principals tie the columns. In disposing of these elements something beyond mere strength is wanted. There must be the element of rigidity to resist the racking stresses of the travelling cranes with their loads, the eccentric loadings of jib cranes, the bending effects on the columns of variations in temperature, of wind stresses, and of snow loads. Nor may the uncertain possible requirements of the future be overlooked, such as the handling of a heavier class of work with the consequent heavier crane service it will demand. It is better to allow a margin in fixing the scantlings than to have to strengthen them later.

The walls, therefore, in a modern building fulfil practically no function except that of affording protection from the weather. Even then a brick filling is desirable for comfort and warmth, and substantial appearance, and this is generally employed in permanent buildings. As an alternative reinforced concrete is used, and in cheap structures corrugated sheets, or even boarding. These last two are liable to early decay, they afford little protection against extremes of temperature, nor does their appearance accord with a sense of architectural harmony.

Another result that has followed the change from masonry to steel is the general abandonment of separating walls between shops that run in parallel and which are occupied in similar kinds of operations. The only separation is that made by the columns or stanchions the centres of which correspond with roof spans. The gain is immense in several ways, in increased light, in general services, and in supervision. On the other hand, walls are useful for hanging various articles on, as backings for vice and light machine benches. So that a low partition wall fills a useful place in some cases, but the outer walls of a building usually suffice for these conveniences.

The improved character of the lighting is one of the great benefits which arise from broad unobstructed areas. The slender steel columns offer little obstacle to the diffusion of light. The present tendency in favour of roof lighting only or chiefly is thus fostered. Windows in side and end walls are still inserted. But this practice is hardly justifiable on merely utilitarian grounds, though architects may prefer to retain them from æsthetic sentiment—the same kind of sentiment which retains the outlines of stone architecture in cast-iron structures. Because windows in walls were formerly always employed they are retained even when the later roof lighting affords the whole of the light which is necessary. They relieve the heavy, drab appearance of a factory building when viewed from outside, though the men working inside can see equally well without them.

Since the remarkable innovation of the standardisation of ships is now being seriously discussed, it seems not unreasonable to suppose that a similar improvement may yet embrace shop buildings. These may in the near future be standardised under the stress of the economical intensive industry that must certainly follow the war. The way has been well prepared and smoothed by the work of the Engineering Standards Committee, who have standardised all the structural materials required. It may not be a long step from the materials to the buildings. It would merely transfer the work of design from the architect, who may often have only a superficial acquaintance with industrial requirements, to the people who would make a speciality of such buildings. A great deal of tedious, separate, independent calculation could be saved, and calculations made once for all for a given kind of building of given proportions. The bases of these are available in books of sections for various loadings, they would only have to be extended to the actual buildings. It would be merely an extension of the principle which is regularly adopted by builders of machine tools, cranes, automobiles and so on. The requirements of a firm being known, a standard design already worked out, exactly or approximately suited to the firm's requirements, could be submitted without the delay entailed by getting out plans *ab initio*. The work could be put in hand at once, and the building completed almost before the plan could be prepared by the general architect. Some-

LOCOMOTIVE BOILER FITTINGS; PENNSYLVANIA RAILROAD.

(For Description, see opposite Page.)

Fig. 74.

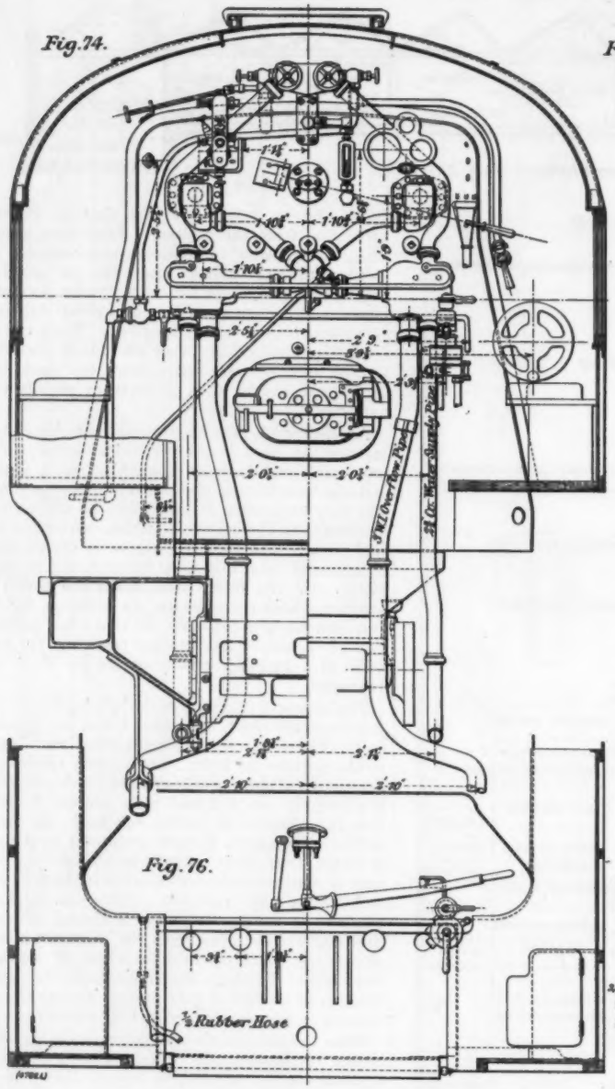


Fig. 75.

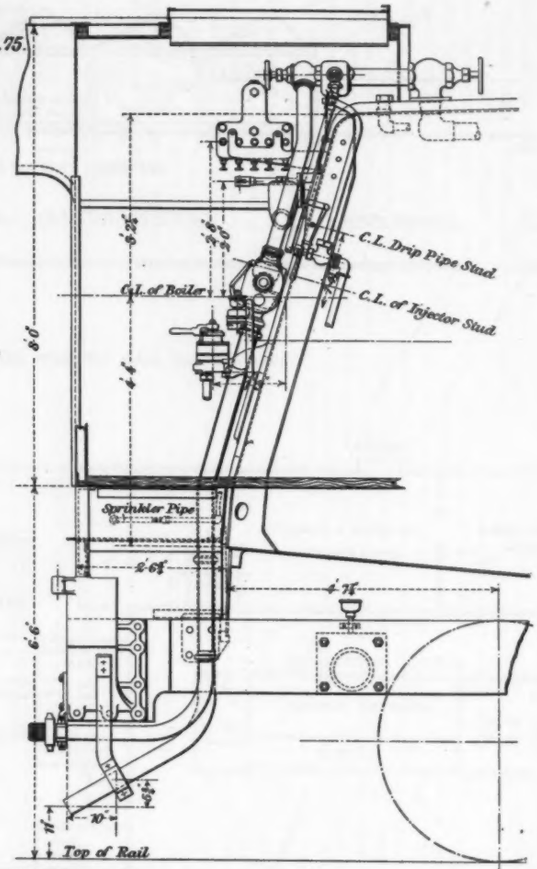


Fig. 76.

Fig. 77.

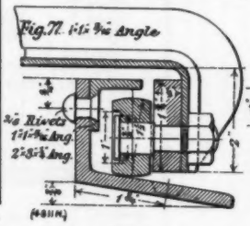


Fig. 78. GAUGE COCK

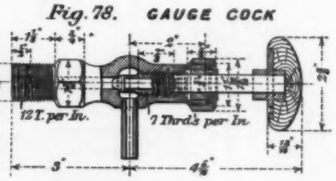


Fig. 79. WATER GAUGE.

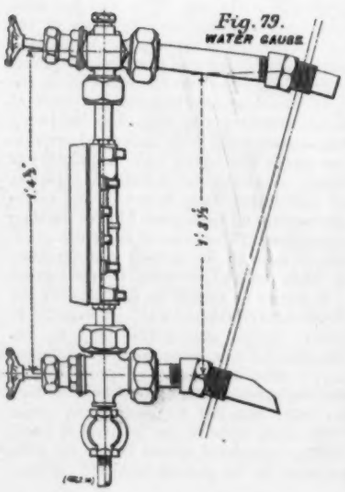


Fig. 80.

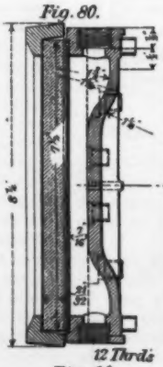


Fig. 81.

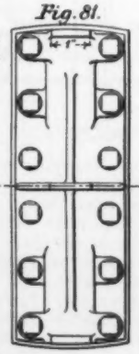


Fig. 82.

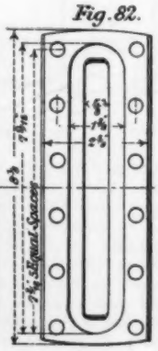


Fig. 83.

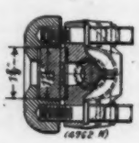


Fig. 84.

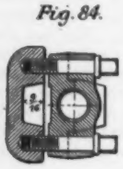


Fig. 85.

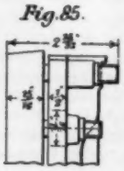


Fig. 86.

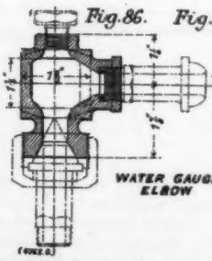


Fig. 87.

Fig. 88.

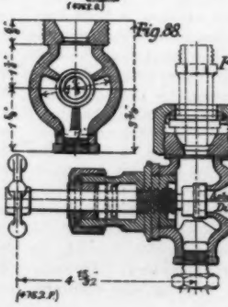
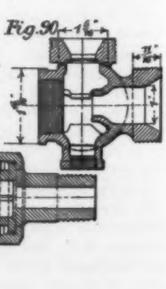
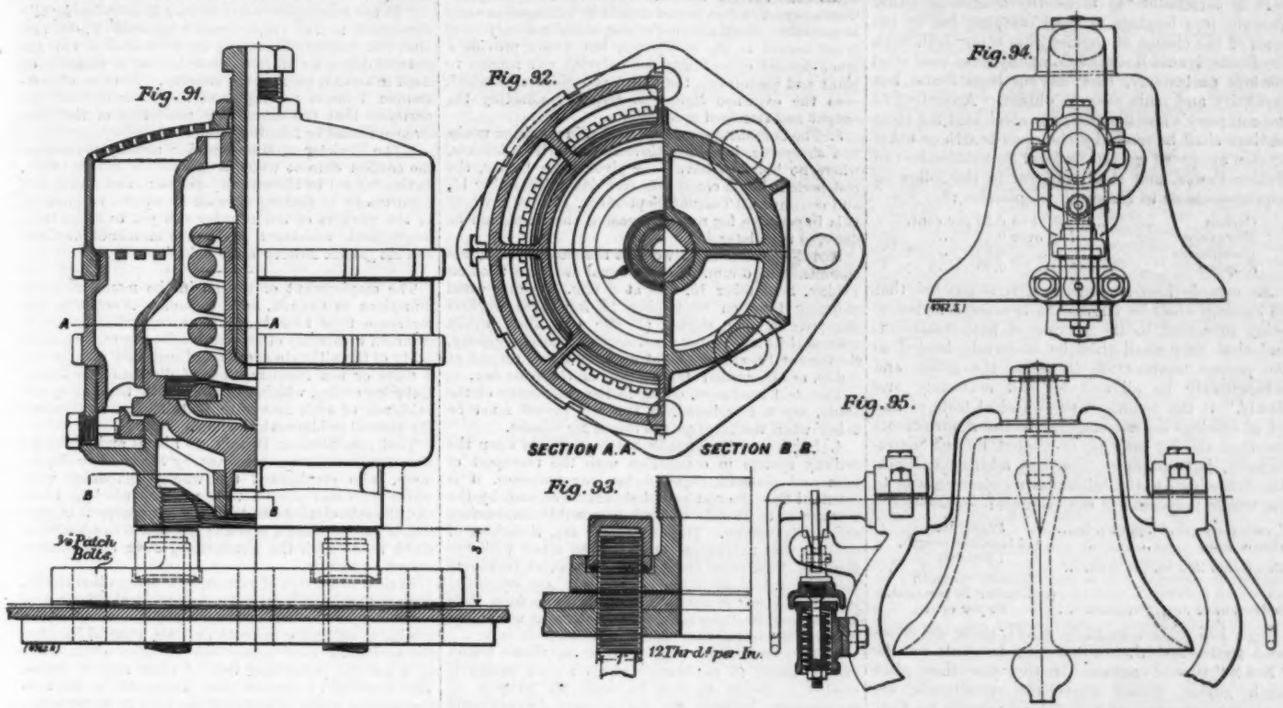


Fig. 89.

Fig. 90.



LOCOMOTIVE BOILER FITTINGS; PENNSYLVANIA RAILROAD.



thing of the kind is being done by firms who supply the steel skeletons for factories. It would only be necessary to extend it to include foundations, floors, lighting, &c. Alternative plans might be available for walls of masonry or concrete or corrugated sheets for side window lights or roof lights, for single-floor buildings or storied buildings to suit the varied requirements of firms. This kind of thing would grow, and the standard patterns would multiply. Already one is aware that when firms erect new buildings they now often adopt designs which by their similarity are pointing the way to standardisation.

The extensions of existing buildings would also be greatly facilitated by such a system, because it would only involve additional units already standardised. A very few weeks would suffice for carrying out erections or extensions which normally occupy the same number of months. The actual cost might generally be less.

HIGH-POWERED LOCOMOTIVES FOR THE PENNSYLVANIA RAILROAD.

(*Continued from page* 150.)

In designing the arrangement of the fittings in the cabs of Pennsylvania Railroad locomotives an effort has been made to retain as far as possible uniform positions of the various details requiring the attention of the engine crew. As enginemen do not always operate the same locomotive, this plan of retaining similar locations for particular details renders the work easier and allows the men better opportunities for observing signals. Figs. 74, 75 and 76, on page 194, show the arrangement of the details in the cabs of the engines with which we are now dealing, and may be regarded as typical.

The cab, which is built of steel and lined with wood, is somewhat shorter than the cabs generally used on American locomotives, and the design is found to be very acceptable to the engine crews, as it is more easy to keep clean than the larger cabs and a better view of signals can be obtained. The reduction in length has been rendered possible by the adoption of screw reversing gear. The cab is provided with large ventilators at the top and back, and, being smaller, it can be kept more comfortable in the summer-time. As seen in Figs. 74 and 75, the top ventilator is a sliding one running on rollers, the details of the latter being shown in Fig. 77. This design has the advantage of giving a large opening through the top of the cab, while it can be closed and fastened so as to be quite water-tight. Before this ventilator was used it was the practice to fit a ventilator consisting of two doors, which were hinged and which opened away from the centre line of the cab. This arrangement, however, was objectionable, as the doors could not be closed when the engine was running, and they were liable to be opened or closed by wind currents when the engine was travelling fast.

The boiler is fitted with three gauge cocks and a water gauge of the Klinger type. The gauge cocks are of the pattern shown in Fig. 78, page 194, and they are mounted on the right-hand side of the back-plate where it is flanged round to meet the side plates. The positions of the cocks are denoted by the holes shown in Figs. 74 and 75. The cocks are mounted so that their centre lines are approximately horizontal, the connections with the boiler being made by means of suitable angular fittings which are tapped into the boiler-plate.

In service conditions there is a rapid flow of water through the tubes supporting the firebrick arch, this tending to disturb the water level reading in the water gauge, and until means were adopted to prevent it, bubbles of steam, when the boiler was working hardest, passed up through the water gauge. To overcome this difficulty the top and bottom water-gauge plugs were extended some distance through the back-plate. This prevented bubbles of steam rising along the front side of the back-plate from entering the water-gauge plugs, and the bottom plugs were cut off at an oblique angle to prevent bubbles of steam which might be rising vertically in the water from passing through the gauge glass. The arrangement is shown in Fig. 79, page 194. The water gauge is, as we have already stated, of the Klinger type, and its details are fully illustrated in Figs. 80 to 89, on page 194. It will be noted that all the connections are metallic, soft packings being eliminated, while the connections between the different parts of the gauge are made adjustable by the use of ball joints. Gauges of this type have been in use for some years on the Pennsylvania Railroad and have been found very satisfactory.

Owing to the extreme height of the boiler the space available for the accommodation of the safety valves (which are located on the crown plate of the outside fire-box) was very limited, and some difficulty was experienced in obtaining safety valves of the proper size—5 in. in diameter—which were low enough to provide the proper clearance. The design adopted is shown by Figs. 91 to 93 above. It will be seen that the attachment of the valve seat to the crown plate is made by means of a flanged fitting, which is itself secured to the crown plate by four patch bolts and four crown stays, the latter passing through the flange and being covered by special nuts as shown in Fig. 93. In the case of the earlier valves fitted trouble was experienced on account of a chattering noise made by the valves just before and just after opening. This inconvenience was, however, got over by the adoption of the arrangement of spring bolt and upper spring button shown by the section on the left-hand side of Fig. 91. In this arrangement it will be noted that the bearing between the spring bolt and spring button is located considerably below the top of the spring, this construction overcoming the tendency of the valve to chatter on its seat.

The want of space which necessitated a special design of safety valve also rendered it necessary to use a bell which could not turn entirely over. The design adopted is shown in Figs. 94 and 95, annexed, a stop spring being fitted which limits the movement of the bell.

In Figs. 96 to 101 on Plate XXII, published with the present issue, we illustrate the main frames of the two classes of locomotive with which we have been dealing, Figs. 96 to 98 showing the frames for the Class "K 4 S," and Figs. 99 to 101 the frames for Class "L 1 S." The frames are of very substantial proportions, an effort having been made to secure the absence of failures, which have been troublesome in the past. It will be seen that for the main part of their length the frames are 6 in. thick, increased to 8 in. at the horns, while the dimensions in the vertical direction are fully given in the illustrations. Each frame is made in two pieces, united by a heavily bolted lap joint at the rear of the hind pair of driving wheels. The rear frames are 3 in. thick, and for the greater part of their length 15 in. deep. The stays crossing the bottoms of the horns are heavy, being 8 in. wide by 4 in. deep at their smallest section, and they are secured to the horns by 1¼ in. collar studs, as shown in Figs. 97, 100 and 104. The toes of the horns of pedestals are tapered

and fit correspondingly tapered recesses in the stays, as shown in detail in Fig. 103.

It is permissible to make the frames of either wrought iron forgings or steel castings, but in the cases of the classes of engines now being dealt with the Pennsylvania Railroad Company have used steel castings exclusively, they having been found less expensive and more easy to obtain. According to the company's specification, the steel used for these castings shall be made by the open-hearth or other process approved by the General Superintendent of Motive Power, and shall conform to the following requirements as to chemical composition :—

Carbon	... ...	0.22 to 0.35 per cent.
Manganese	... ...	Not over 0.75 ,,
Phosphorus	... ...	,, 0.05 ,,
Sulphur	... ...	,, 0.05 ,,

As regards heat-treatment, it is stipulated that all castings shall be allowed to become cold before being subjected to the process of heat-treatment, and that they shall then be uniformly heated to the proper temperature to refine the grain, and subsequently be allowed to cool uniformly and slowly. If the results of the physical tests of any lot of castings do not conform to the requirements specified the lot may be re-treated by the manufacturer, but not more than two additional times. The following are the minimum requirements as to the tensile properties of the castings :—

Tensile strength, lb. per sq. in....	50,000 lb.
Elastic limit ,, ,,	0.4 tensile strength.
Elongation in 2 in. per cent. ...	1,400,000 / Tensile strength (not under 20 per cent.)
Reduction of area, per cent. ...	30 per cent.

Figs. 105 to 110, on Plate XXII, show the cross-head guides and their supporting brackets for the "K 4 S" type of engines. In this case three-piece single guides, placed above the cross-heads, are used, the arrangement being clearly shown by Figs. 108 and 109. As seen from the section of guides given in Fig. 109, this design gives a large bearing area on the upper guide to receive the pressure imposed when the engine is running forward, and a comparatively small bearing surface on the bottom guides. It will also be seen from this view and Fig. 109 that the guide yoke, or bracket, in addition to being fixed to the frame, is connected to the boiler by a plate ½ in. thick by 1 ft. 8½ in. wide.

In the case of the engines of the "L 1 S" type, the cross-head guides are of the ordinary double type, as shown with their supporting bracket, or yoke, in Figs. 111 to 118 on Plate XXII. These views show the whole design so clearly that any detailed description is unnecessary. In the case of both classes of engine the guides are of forged steel, while the guide yokes are steel castings. It will be seen from Figs. 109 and 115 that these castings extend right across the engine from frame to frame, thus forming efficient stays.

(To be continued.)

INDUSTRIAL NOTES.

THE Committee under the chairmanship of the Right Hon. Arthur Henderson, M.P., appointed "to consider and recommend as to arrangements to be made for the release of workmen for holidays in relays so as to maintain without interruption an adequate output of munitions," reported their proceedings to the Right Hon. Edwin J. Montagu, M.P., Minister of Munitions, on August 23. The Committee arrived at the following conclusions :—

1. The Committee are of opinion that, on the evidence submitted, the release of munition workers for holidays in relays is, having regard to military exigencies, open to very grave objections for the following reasons :—

(*a*) Except in a very few instances they could not be granted without seriously affecting the output of munitions. (*b*) In whatever form they were arranged they would, owing to the lack of qualified substitutes, seriously interrupt the sequence of operations. (*c*) They would interfere with, if not make practically impossible, the repairs and adjustments absolutely necessary in buildings, plant and machinery. (*d*) They would assist in the continuance of the holiday spirit and lead to an amount of travelling which, so long as the relays lasted, would cause congestion on the railways, and affect the transport of troops and munitions and other material required for war purposes.

2. Though holidays in relays have been found practically impossible, the Committee are of the opinion that munition workers, both men and women, including the staff and officials, have been engaged in many cases for excessive hours over a long period. Their sequent physical and mental exhaustion renders it essential that, in all cases where the Army requirements permit, a rest period should be arranged as early as possible. Such a period of rest would not only be of great benefit to the employees, but would provide a much-needed opportunity for carrying out repairs to plant and machinery, the defective condition of which —as the evidence shows—is seriously affecting the output and standard production.

3. The Committee recommend that in munition works and shipyards, including Government establishments, where no holidays have been given since Easter, the rest period should commence on Friday, September 15, and continue till Tuesday, September, 19, except where it is imperative for national reasons that it should be deferred till a later date.

NOTE.—(*a*) For night workers the rest period would commence at 6 a.m. or other usual stopping time on Friday, September 15, and at 5 p.m. or other usual stopping time on September 15 for those workers engaged on day shifts. (*b*) The day shift would resume at 6 a.m or other usual starting time on Tuesday, September 10, and the night workers would resume at 5 p.m. or other usual starting time on the same day.

The steel producers, owing to the peculiarity of the trade, are not included, as the rest period must be taken when the furnaces are closed for repairs.

4. In view of the already heavy demands upon the railway system in connection with the transport of men and material required for war purposes, it is essential that the rest period should be so used by the workers as to obviate as much as possible unnecessary railway travelling. The Committee are, therefore, of opinion that arrangements should be made with the Railway Executive Committee for special travelling facilities for those workers only who are employed temporarily in the national interests away from their homes, such facilities to be strictly confined within the limits of the rest period officially granted.

5. The Committee suggest that in those trades closely allied to munitions where a rest period is needed it should at once be made the subject of negotiations between the Government Departments and the employers and workmen's organisations concerned as to whether the date and other conditions suggested in this report should not be adopted.

6. In conclusion, the Committee wish to express their thanks to the witnesses who have been good enough to give evidence before them—a service which must have caused great inconvenience owing to the short notice which it was necessary to give them, arising from the need of submitting this report at the earliest possible date.

The Committee finally desire to record their appreciation of the work and the valuable assistance given by the Secretary.

NOTE.—The Minister accepted the unanimous recommendation of the Committee that no general system of relay holidays was practicable, and accepted the recommendation that there should be a week-end holiday. In view of the paramount military considerations he decided, however, after consultation with the Committee, that the week-end, instead of that proposed by the Committee, viz., Friday, September 15, to Tuesday, September 19, should be Thursday, September 28, to Sunday, October 1. Both dates are inclusive.

With reference to the above, we reproduce below a letter issued to the Press by the Right Hon. Arthur Henderson, M.P. :—

"It will be remembered that at the Trade Union Conference, which was held at Caxton Hall to consider the question of holidays, it was unanimously decided to recommend to the country that all holidays should be suspended until such time as the military exigencies permitted them to be taken. It is not necessary for me to repeat what has already been said by Sir Douglas Haig himself as to the results which have been obtained in France with the devoted assistance of the munition workers, but in spite of the continuing success of the offensive the military position does not yet permit of any slackening off in the output.

"In view of this position, the Government appointed a Committee, of which I was Chairman, to consider whether any system of holidays by relays could be devised which would not interfere with output but would yet give the workers the rest which they so much require.

"From the report of that Committee (the conclusions of which are given above) it will be seen that that Committee came to the conclusion that to grant holidays in relays was impossible, and their ultimate conclusion was in favour of a week-end rest.

"The spirit in which the Conference responded to the appeal of the Government is shown by the message sent to Sir Douglas Haig, in which, on behalf of all the organised workers, they pledge themselves to recommend the *postponement of all holidays*, general and local, which involve interruption of production, *until such time as they are assured by him that military exigencies permit* of the postponed holidays being taken.

"In the same spirit the country generally has loyally responded to the Government's appeal. There are, however, indications at the moment that a not unnatural desire for an immediate holiday is manifesting itself in certain parts of the country. In these circumstances I desire to emphasise that it is of vital importance that the unanimous resolution of the Conference should be faithfully observed.

"The Minister of Munitions has already announced the earliest date at which a rest period can be taken, having regard to the military position, and I take this opportunity of making as wide an appeal as possible to the workers of the country not yet to relax their magnificent assistance to the Commander-in-Chief and his gallant Armies in the field."

The employment of women in the manufacture of munitions in Canada, says *Canadian Machinery*, has for some time now been an accomplished fact. In common with many other war developments, the probability of the ultimate adoption of such help had become a more or less familiar topic of discussion in manufacturing circles, which, combined with the widespread existence of such labour in Britain, had familiarised the general public with the idea.

That conditions in Britain are liberal and successful were evidenced some time ago by Sir William Beardmore, who emphasised the whole-heartedness with which girls and women were working machine tools, and the stimulating effects of the knowledge that their efforts were successful beyond expectation has doubtless much to do with the wonderful growth of munitions output in Britain.

In their utilisation of women, as in many other things, our enemies have betrayed a peculiar lack of common sense, not to mention consideration, and advices from a reliable authority indicate that the Central Empires are sacrificing their women on the altar of industry in a manner paralleling that of their men in battle. The number of women now employed in German engineering works is frequently as high as 80 per cent., and the question of compulsory service is being actively agitated in Germany, the claim being that every woman should be obliged to serve her country in one way or another.

As stated on page 150 *ante*, Mr. Robert Smillie, speaking at the recent annual conference of the National Union of Scottish Mine Workers, moved a resolution, which was carried, recommending the members of the Union to work six days a week. At the present time they work ten or eleven days fortnightly. The ballot referred to was taken last Monday, when it was found that 24,650 voted for, whilst 34,516 voted against, giving a majority of 9,866 against the proposal.

The sixty-eighth quarterly report, dated June 30 last, issued by the General Federation of Trade Unions states that "Concern for the problems of demobilisation continues. The programme which the Management Committee outlined in June, 1915, has been generally adopted, and each successive deputation to Ministers emphasises one or more of the proposals then made. Whether action has been taken in time, no man can say until the crisis comes and the machinery is tested. The pity is that action was not more expeditious and open. Criticism of the Government's delay in formulating proposals loses point, however, in face of labour's similar inactivity. No general or reasonably clear understanding has been reached in respect of women's trade organisation, yet women will be the most important factor in the after-war problem of employment and wages. She will inevitably lower the general average of men's wages unless very definite steps are taken to develop within her the spirit and power of resistance. Evading the problem does not solve it, and the wisest thing the trade unions could do would be to set aside a portion of their time and money for this purpose. The woman is in the factory, she is working the machine, she is welding and brazing, and she is doing these things in a manner which at present wins commendation from her employer and the factory inspector. She is doing these things at rates which are lower than men's rates. Is she to continue on this work? If so, is she to continue at lower rates? Or will the trade unions take the matter in hand and help her to organise? These are questions that should be answered now."

On June 30 the Federation had a total membership of 1,072,233, the membership on which contributions are paid being 874,446. The affiliated societies numbered 143, whilst 143,884*l.* formed the total of the present funds.

Puddlers in Eastern Pennsylvania rolling-mills, says *The Iron Age*, had their wages advanced on August 1

to 7 dols. per ton, the highest rate ever paid in that part of the country. The former rate was 6 dols. per ton.

The National Conference Committee of the Railways, says the *Railway Age Gazette*, New York, applied, on August 9, to the United States Board of Mediation and Conciliation for its services for the purpose of bringing about an amicable adjustment of the controversy with the four brotherhoods of train service employees who voted to strike to enforce their demands for an eight-hour basic day and time and a half for overtime in freight and yard service.

The results of the strike vote, as announced on August 8, subject to slight corrections, were as follows:—Brotherhood of Locomotive Engineers, S.E. district, for a strike, 98.72 per cent.; W. district, 90.35 per cent.; E. district, 94.64 per cent. Brotherhood of Locomotive Firemen and Enginemen, for a strike, 98.1 per cent.; including non-union men, 98.3 per cent.; total vote, 70,653. Brotherhood of Railroad Trainmen, for a strike, 129,108, or 97 per cent.; against a strike, 4,276. Order of Railway Conductors, for a strike, W. district, 84.3 per cent.; E. district, 84.8 per cent.; S.E. district, 93.4 per cent.

Early in the week, President Wilson addressed a joint session of Congress stating that a Bill had been drafted to deal with the situation. He asked both Houses to pass it immediately. The Bill is said to provide for an eight-hour day for railwaymen and for the establishing of a Commission to investigate disputes in regard to wages and to determine carriage rates. Its further object is to prohibit strikes and lock-outs during the period of investigation and to authorise the Government, in case of a dispute, to draft men into the service to work the railways until the dispute be over.

The Employment Department of the Board of Trade is prepared to receive from employers inquiries and proposals with regard to the employment of civilian prisoners of war, and to make the necessary arrangements with the authorities concerned. Inquiries should be addressed to the Assistant Secretary, Board of Trade Employment Department, Queen Anne's Chambers, Broadway, Westminster, S.W.

Civilian prisoners of war may be employed upon work which is not connected with the war in the following ways. They may, in suitable cases, be permitted to perform, within existing internment camps, such work, upon materials supplied by employers, as does not require elaborate plant or equipment; or a number of prisoners may be specially interned in suitable premises where they can live and work upon some process of manufacture, if the employer is willing to install the necessary plant and to provide the technical supervision required. Proposals to employ less than 100 men under an arrangement of the latter kind cannot as a rule be entertained, owing to the cost of guarding the prisoners. It may be mentioned that there are a certain number of prisoners who are skilled workmen, but the majority are persons who have done more or less unskilled manual work of various kinds.

To assist in meeting the shortage of agricultural labour, individual selected prisoners can occasionally be released, in approved cases, under strict conditions, to work for individual farmers. In such cases the farmer must arrange for the man to reside on his premises and undertake to inform the police at once of any misconduct, as the man will then be re-interned. Men used to agricultural labour can be supplied. No men will be released to go into a prohibited area.

In all the above cases it will be necessary for the employer to pay the regular rate of wages paid to British workmen for similar work. A deduction will be made for maintenance and other expenses, and the balance will be credited to the man.

The arrangements outlined above have been drawn up in consultation with the inter-departmental Committee which, under the chairmanship of Lord Newton, is advising the Government upon questions concerning prisoners of war in the United Kingdom.

DOCTOR TECHNICHES.—A new degree of Doctor Technicheş, or, abbreviated, Dr. Techn., at the technical high school in Copenhagen, has been instituted by a Royal Warrant. This degree is open to those who have passed, with honours, one of the final polytechnic examinations, or one of the final examinations at the university of Copenhagen, or been admitted as magister. The candidate having established his qualifications, he can obtain the necessary permission to compete for the degree on the recommendation of the technical high school. He then submits a written treatise on an appropriate subject, and when this has been accepted by the board of professors, he has to defend the same orally at an official function. Having duly secured his degree, the Dr. Techn. has the right to lecture at the technical high school, provided the accommodation is available. In Germany the degree of Dr. Ing. was introduced before the beginning of this century. The degree is a much-coveted distinction (there were in 1913 267 promotions at the technical high schools in Germany) and there can be no question but that it has served as a potent lever in the matter of technical-scientific study and research.

DRAUGHTSMEN.

TO THE EDITOR OF ENGINEERING.

SIR,—The letter in your issue of this week over the *nom de plume* of "Chief Draughtsman" is interesting, if only as an illustration of how utterly biased and illogical it is possible for an individual to be.

It is evident that, so far as "Chief Draughtsman" is concerned, the obvious is obscured by a cloud of mental mist which augurs ill for the success of the drawing office over which he presumably presides.

Your readers will probably be aware, that almost every draughtsman of military age has attested under Lord Derby's scheme. His patriotism is, therefore, not in question. If he is not at the front, it is because he is required elsewhere. But, because he is safe and sound at home, it is no reason why he should allow himself to be exploited by others.

If it is "low" for draughtsmen to amalgamate, it is equally "low" for doctors, accountants, chemists, teachers and *employers*. If it is unpatriotic for draughtsmen to desire their just due, it is equally unpatriotic for certain employers to be pocketing the enormous profits which the war has given them the opportunity of making.

The object of the Engineering and Shipbuilding Draughtsmen's Association, is not, however, to harass and plunder employers, but to protect its members against oppression, injustice, and particularly against persons of the type of "Chief Draughtsman." He magnanimously concludes by saying we are "good sorts"; but when the Association has achieved its objects he will most certainly find us even "better sorts," and possibly better draughtsmen.

I am, Sir, Yours faithfully, "ERIMUS."

TO THE EDITOR OF ENGINEERING.

SIR,—In reply to "Chief Draughtsman's" letter in your issue of 25th inst., it is evident that he knows very little about the Association of Shipbuilding and Engineering Draughtsmen. It is not a trade union, but merely a means whereby the hitherto much-neglected "brains of engineering" may be brought more prominently before the employers' notice. Further, there is no mention in their programme of the efficient and non-efficient draughtsmen having equal salaries.

I agree that the average draughtsman is a thoroughly "good sort," and am sorry to state that his goodness is played upon by some "Chief Draughtsmen" as much for their (Chief Draughtsmen's) own personal glory as for the employers' benefit. The stay-at-home draughtsman (and some had to be left) is not lacking in patriotism, as can be proved by looking at the increases in wages given to nearly all the branches of engineering, bar the draughtsman, since the war started; and if we take 12s. as the present value of 1l. most of these "stay-at-homes" are working for something like a reduction of 8s. per week compared with pre-war wages, and this quite apart from the extra calls made voluntary upon the pocket during the past two years.

"Chief Draughtsman's" remarks about the deterioration of your columns brought about by these letters are quite "out of order" altogether. Where should draughtsmen be discussed, if not in ENGINEERING? Perhaps Mr. Blair (Secretary of the Association) will send "Chief Draughtsman" some of the Association's literature for his enlightenment. Apologising for taking up so much of your valuable space, and thanking you,

I am, Sir,
"A MEMBER OF THE A.S.E.D."

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent, "Chief Draughtsman," apparently much annoyed at your having published a copy of correspondence with a Government Department, ventures to prophesy that, in future, drawing-office routine will be hampered by "trade unionism, limitation of output, equal pay for efficiency and non-efficiency," &c.

Such little pleasantries of workmen are again to receive official sanction after the war; and your correspondent, knowing that draughtsmen are, by law, classed as workmen, is justified in feeling anxious regarding the future. The danger is recognised by draughtsmen, and has resulted in a large influx to the Association of Engineering and Shipbuilding Draughtsmen—a body which is *not* a trade union, but which exists to foster a higher sense of the importance of the profession. Your correspondent, "Chief Draughtsman," should become a member.

Yours faithfully,
August 29, 1916. "ABIMELECH."

TO THE EDITOR OF ENGINEERING.

SIR,—I have read the letter on the above subject signed by "Chief Draughtsman," and am a little surprised at the tone of same. There are one or two points raised—more particularly the Association of Engineering and Shipbuilding Draughtsmen—which somehow or other he has lowered to the level of a common trade union, with the accompanying troubles. Then there are his remarks regarding time and quarter for deferred holidays, which he will be very well aware was decreed by our Government, so if there is any blame or stigma attached to this then he will require to saddle the Government with it.

Like "Chief Draughtsman," I deprecate the idea of paying time and a quarter for holidays, which were only delayed, also the great number of advances in wages granted to engineering trades since the war started, as it is in my opinion due to these conditions that everything is inflated in price much to the disadvantage of those people who are not on war work. I am, however, much surprised to note that "Chief Draughtsman" would have the draughtsmen to do all the sacrificing for the engineering trades even to the length of not "soiling their hands" with the holiday bonus. Regarding the latter, I think very few draughtsmen got the option of accepting or declining same, and if a letter from the Association of Engineering and Shipbuilding Draughtsmen has remedied this point then I think it has justified its existence already.

Referring to his other point, viz., the Association of Engineering and Shipbuilding Draughtsmen, I think there is much room for mutual help amongst draughtsmen, and I think it is with this object in view that the aforementioned association was started. Perhaps if "Chief Draughtsman" makes a thorough perusal of the pamphlet explaining the aims and objects of the Association, he may yet himself be numbered on its roll and be able to contribute some hints on how best to improve the status of the draughtsmen at a subsequent meeting of the branch near to his home.

The only other point I refer to is that referring to "those who stay at home" which I take it refers to those of military age. "Chief Draughtsman's" mention of them would lead one to the conclusion that *he*, at any rate, is well over the military age. If that be not so, then he will himself be a defaulter, seeing all *men* between the ages of 18 and 41 automatically become soldiers under the Military Service Act unless exempted for some reason or other. He would in any case have been wise to qualify his remarks on those who are not yet called on to make the same sacrifice as the soldier, whom we all think of with deepest gratitude.

A MEMBER.

THE PRINCIPLE OF RELATIVITY.

TO THE EDITOR OF ENGINEERING.

SIR,—I have been trying very hard during the past two years to understand what it is all about, and I would refer your correspondent to a very learned essay on the subject, by Dr. Wildon Carr, in the *Philosophical Review* of January, 1915; for it is evident that philosophers do not use words in the same sense as we do. For instance, quoting Professor Bergson, *movement does not imply something that is movable*, the author goes on to say: "The ground of the principle of original movement is that there is no way of deriving movement from immobility, because movement is more than immobility and the more cannot be derived from the less, but from movement we can derive immobility. Given original things, be they material atoms or the immutable Form or Essence of the Platonic Ideas, movement is something added to them from without, or else it is not part of their reality but only an appearance. On the other hand, given original movement, things are derived by simple interruption, they are arrests or stops of a movement."

Possibly the meaning of the foregoing may be quite clear to some people, but I am

London, August 26, 1916. "PUZZLED."

THE QUEBEC BRIDGE.—Both cantilevers of the Quebec Bridge are now complete, and it is hoped that the central suspended span will be floated in place and connected up by about the middle of September, or fully a month ahead of schedule time.

THE BRITISH MANNESMANN TUBE COMPANY, LIMITED.—We learn that the shares of the British Mannesmann Tube Company, Limited, have now been sold by the Public Trustee to a British group including Sir Hugh Bell, Mr. A. J. Dorman, Messrs. Balfour, Williamson and Co., and Messrs. Higginson and Co. The British Mannesmann Tube Company, Limited, have large weldless tube works at Swansea, and intend to erect additional tube mills at Newport (Mon.).

NEW ELECTRO-CHEMICAL INDUSTRY IN NORWAY.—A French-American syndicate is about to start a large electro-chemical works in Norway, in the Telemarken district. Some 100,000 h.p. are said to be needed for their purposes, and it was understood that this power would be drawn from the Toke. This, however, turns out not to be the case, the requisite power is to be supplied by the Maar falls in Tinn. When the necessary damming and regulation has been done a capacity of 135,000 h.p. is calculated upon. When the Maar falls are fully exploited an aggregate of 180,000 h.p. may even be anticipated. Two or three power stations can be built, and the locality at Maarvik is well suited for factories, the sea being very deep there and the place well adapted for quay construction.

COAL IN THE FEDERATED MALAY STATES.—Coal, a recent discovery, is now one of the commercial products of the Federated Malay States. It is being mined in Selangor, not far from Kuala Lumpur, by the Malayan Collieries, Limited. Though work on an extensive scale was not begun till September last, 11,523 tons of coal were raised in 1915, and it is stated by Mr. W. Eyre Kenny, Senior Warden of Mines, that this coal, where used in suitable plant, will exercise an important influence on mining and other costs, and it is hoped will tend to reduce the consumption of firewood. Among other consumers, two large mines have taken the coal into use, a considerable saving in working expenses having resulted, and a contract has been entered into for part supply of the Federated Malay States Railways. The power plant at the mine comprises two Babcock and Wilcox boilers fitted with stepped grates, supplying steam to the steam winding plant and to a steam electric power station. Two inclined shafts have been sunk to a distance (on an incline) of 846 ft. and 800 ft. respectively, together with a ventilating shaft and airways, supplied by an electrically-driven fan. Experiments in briquetting are in progress, under the supervision of Professor Bone, in England.

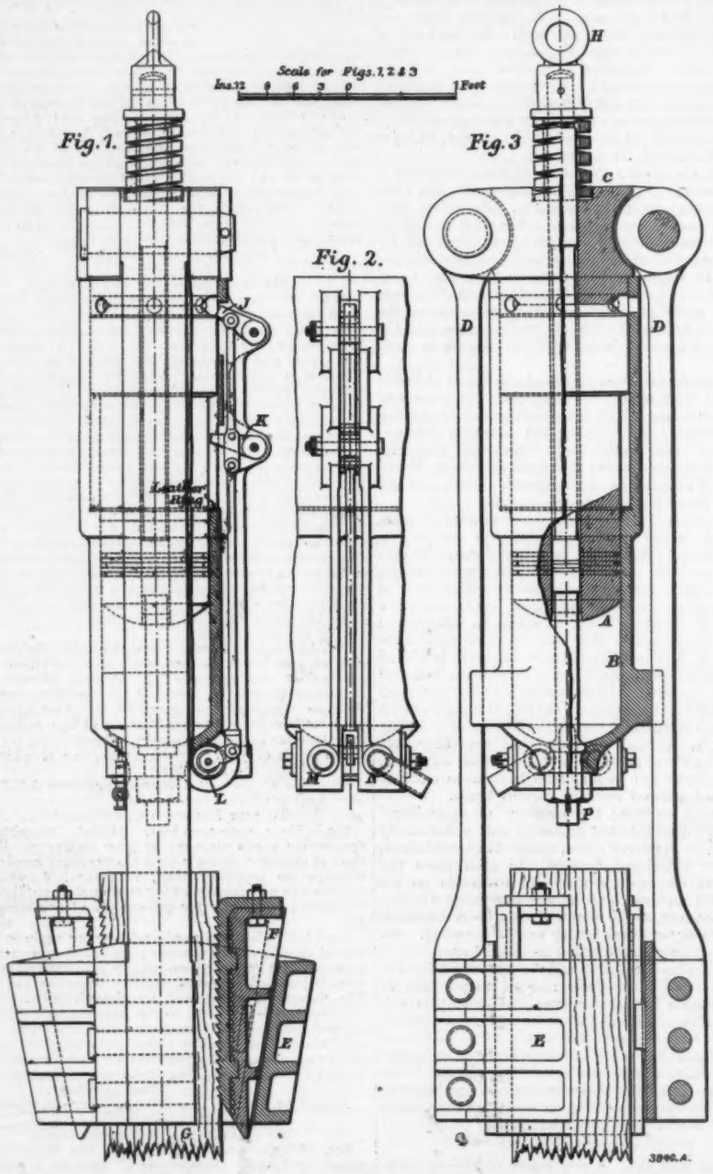
PILE-DRAWING.

COMPARATIVELY little inventive ingenuity has been exercised in devising machinery for the drawing of piles, and thus a somewhat primitive method is still largely in vogue. In cases where the tops of the piles are under water-level, as in temporary cofferdams, bridge foundations and corresponding subaqueous works, the usual procedure has been to attach the piles to the top of a barge or pontoon, so that the rising of the tide and the buoyancy of the pontoon drew the piles from the bottom of the river or the sea bed. It will be recognised that this was not only a slow process, but was attended with considerable risk of the barge being overturned or being water-logged. In operating on land many methods were adopted, all equally crude; for instance, by the use of jacks and union screws, or by pulley blocks suspended to a crane or other structure. The time taken and the cost were in many cases prohibitive, and often the piles were left in, if at all convenient, and their upper part cut away to obviate obstruction. Curiously enough, the war has had the effect of attracting increased attention to this subject of pile-drawing, because of the greatly enhanced price of timber. There is no need here to point a moral by adverting to the lack of foresight in arboriculture, and to the failure to recognise the immense importance of timber-growing in this country. That may be remedied, but in the meantime it is a significant fact that the price of pitch pine is 5*s.* 6*d.* per cubic foot, whereas in normal times the price was as low as 1*s.* 9*d.* per cubic foot. This is due, of course, to the dearth of tonnage available for transporting the timber from foreign countries to our own. The consequence is that it is found profitable, within certain limits, to draw piling which formerly would have been left in position. The successful method under review is of great assistance in reducing the cost.

Messrs. Howard Lacy, Limited, 39, Victoria-street, London, S.W., have pointed out to us that much of interest is disclosed in connection with the application of the plant they have in use. It is another case of the appliances, however admirable, being dependent for their success on the method of application. Before dealing with the application, however, as illustrated in the views on page 202, it may be worth while describing the extractor itself, and we therefore reproduce a drawing which appeared in our issue of April 24, 1914.

The extractor, which is constructed by the Ransome-ver-Mehr Machinery Co., Ltd., London, is devised to reverse the process of pile-driving. Instead of the blow being struck by the force of gravity acting on the hammer dropping from a height on to the top of the pile, steam is utilised in the cylinder to give an upward blow to an anvil in the form of a cross-head, which is connected by vertical links to a grip-box placed under the cylinder and carrying wedge-shape serrated jaws, which, with the grip-box, surround the pile, so that, as the steam impinges on the piston and strikes the anvil, an upward pull is exerted on the top of the pile through the connecting links and the grip-box. The engravings annexed, Figs. 1 to 3, show in detail the main units of the extractor. A is the piston or monkey working in the cast-steel cylinder B, and impinging in its upward stroke on the forged-steel anvil block, while D, D are the forged-steel connecting rods to the cast-steel grip-box E, in which are fitted the serrated cast-steel wedges or jaws F, to engage with the pile G. The whole machine is suspended from the hook H, which forms part of a rod passing through the centre of the anvil, piston, or monkey, and cylinder bottom, where it is secured by a nut P. Interposed between the anvil and the collar on the top of this rod is a spring, so that the impact of the blow on the anvil is not distributed to the wire rope on which the extractor is suspended. It will be remembered that the piston, or monkey, descends by gravity, and when near the lowest position it strikes a valve tappet K, which opens the steam valve M, admitting live steam to the cylinder. When the piston or monkey has nearly reached the limit of its upward stroke it strikes a valve tappet J, which closes the steam valve M and opens the exhaust valve N, by means of the gear shown in the detail view, Fig. 2.

It will be seen that the extractor has a wide range of action. Obviously the cylinder cannot operate under the water level, but this disadvantage can be overcome by increasing the length of the connecting rods between the anvil and the grip-box, so that the cylinder may be just above the water level while the grip-box is lowered to be connected to the top of the pile. An important element in the success of the extractor is the abundance of steam supply, which was foreseen and provided by the contractors. This is transmitted through flexible tubing. Once the hammering action has been commenced, it is important that it should not cease until the pile has been extracted, or is sufficiently loose to enable it to be easily withdrawn by a small crane or by winches arranged to do so. If there is any discontinuity in the hammering, the jaws are likely to get out of position, and in the hands of the inexperienced it is difficult to restart the operation without again re-setting the serrated wedge jaws into the true position, because in some timbers —for instance, in memel—the serrated wedge jaws tend to crush the pile owing to the jaws being out of alignment, and re-setting is necessary. Indeed, in some timbers it sometimes happens where great care is not exercised that a neck is formed where the jaws grip the pile, leaving a protruding or relatively enlarged head, rendering it difficult for the grip-box to be moved clear of the pile-head after the pile has been drawn. Watching the operation of the pile extractor, the writer was forced to the conclusion that some method of suspension of the wedge jaws is desirable, and this, by the way, is receiving the contractors' attention. This would save a vast amount of time and labour, because under certain unavoidable circumstances one wedge may descend on the grip-box to a greater depth than the other, so that the extractor is not in true alignment with the pile, and the blow is therefore not direct unless adjustment is made, which is difficult where the pile is under the water level.



The method of suspending the extractor is another important element in its success and rapidity of operation. In some cases it is hung on a pile-driving machine, but one of the most effective installations is that used by Messrs. Howard Lacy in drawing piles at the large shipbuilding berths of the now dismantled Thames Ironworks. Here a 10-ton steam derrick crane is utilised, specially adapted for the purpose and having a 60-ft. jib. The king-post under the mast is mounted on a three-wheeled bogie. One of the two guys is mounted on a two-wheeled bogie, and the other on a three-wheeled bogie; on the latter is the boiler to supply steam to the extractor. This boiler is of the Field tube type. The weight of the crane without any ballast is 23 tons, but two counterweights have been

fitted at the bottom of the guys, each of about 40 tons, making a total weight with bogies, &c., of approximately 106 tons. The three bogies carrying the crane travel on two sets of rails, the bogies with the king-post and one guy being on one set of rails, and the other bogie with the other guy and Field tube boiler on a second set. The two legs are bound together by a diagonal tie to keep them in alignment. The crane is drawn backwards and forwards on the rails by a winch. Steam is conveyed to the cylinder of the extractor by a flexible metallic pipe and, conveniently placed, is a sight-feed lubricator, as experience showed that the drain cock fitted to the bottom of the cylinder was apt to open of itself, owing to the vibration of the extractor during operations, rendering the oiling arrangement within the cylinder ineffective.

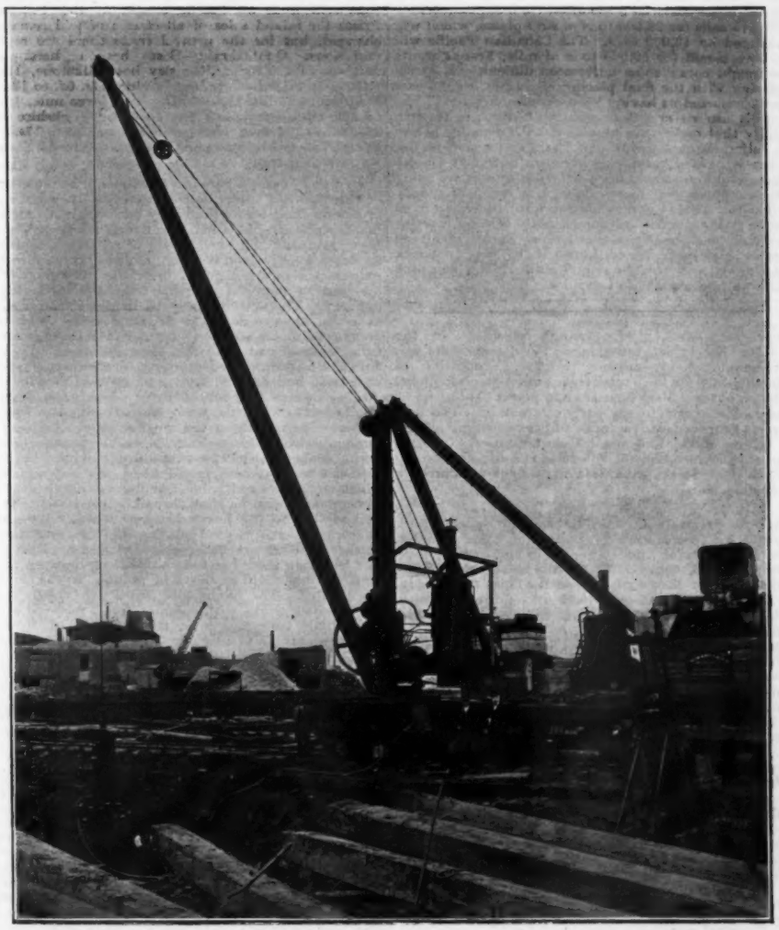


FIG. 4.

The crane installation described, which is illustrated by Fig. 4 annexed, and also by Fig. 5, on page 202, has the advantage that the extractor is free to oscillate or vibrate when in operation, and thus there is secured the great advantage due to the vibrational movement in slackening the pile, affording great gain, particularly when the pile is in heavy clay, as at the Thames Ironworks. Moreover, when the extractor is working the crane engine is set in motion, maintaining a tensile strain on the suspension wire rope, so that the hammering action of the extractor is assisted by the pull of the crane. In Messrs. Howard Lacy's installation the extractor is of ample size and capable of delivering about 74 blows per minute. The total strength of the blow delivered is approximately 6 tons, which is augmented by the pull of the crane. Another advantage of the crane installation is that the crane does not require to be moved, as in the case of the piling machine, for every pile. The crane in Messrs. Howard Lacy's installation commands an arc of 270 deg., and the extractor can be lowered down on to any pile within a wide radius. The whole portable plant is carried, on the same level as the high ground, on two heavily timbered temporary stages, in order to remove the piles from the extreme end of the slipways, which are at a much lower level in the river.

In one of the shipbuilding berths being operated upon there were about 1,200 piles, 13 in. to 14 in. square, the timber being of pitch pine and memel. They were driven in the usual way to support the keel-blocks and the bilge timbers, with occasional rows across the full width of the berth. There were the usual cap timbers across the top. These piles ranged in length from 29 ft. to 36 ft. in the upper part of the berth, and from 15 to 20 ft. at the lower part, and were driven for their full length into the London clay, the upper packing between the rows of piles being slag and other filling material. Some thousands of cubic feet of these pile timbers have already been removed, and a great deal of it has gone to assist our operations in France, the timber being in excellent state of preservation. The average time for drawing the pile by the plant described is well under 3 minutes, but in a few cases as long as 10 minutes has been taken, depending on the number of blows struck by the extractor. It is noteworthy that frequently with piles of equal dimensions within a distance of 3 ft. of each other, and driven to the same depth in the clay, many more blows are required to extract one than the other. As an instance of this, three piles of equal dimensions were tested as to the number of blows. No. 1 took 26 blows to raise it, No. 2 (which was 2 ft. 6 in. away from No. 1) took 431 blows. No. 3, within 3 ft. of No. 2, took only 72 blows. The steam pressure at the extractor was the same in all three cases. As many as 130 piles, 35 ft. long and 13 in. by 13 in. square, on the average, have been drawn in a week, in addition to the removal of the timber cappings and excavation before the tops of the piles were exposed to enable the extractor to take hold of each pile. The usual practice is to draw the piles, until they are comparatively loose, to a height above high-water level, when the crane can be applied to draw them out, and allow them to float on the surface of the adjacent water to be formed into rafts. The plant, as equipped and in operation, cost about 1,500*l.*, which is much greater than the cost of the plant for the primitive method of pile extraction; but the additional outlay is warranted, as with the plant under review the output is from three to four times that of the primitive method.

The whole of these piles, including their cappings, are frequently buried to some depth in this particular place by accumulation of earth and river sludge brought up by the tide. All the surface material is first removed by means of a single chain close-tine grab operated from the crane above described by replacing the pile extractor by the grab on the wire rope suspension. The material packed between the piles then has to be removed by manual labour. The amount of material to be removed on this work averages, so far, about 4 cubic yards per pile. Many of the piles are so closely driven that the extractor jaws cannot be placed to grip the pile, and in these cases the method adopted by the contractors is to drive heavy wedges between two piles until they are far enough apart to admit the toe of a Haley jack, which is then adjusted so that a 6 to 10-ton pressure is brought to bear between the piles, which finally give way to the distance of 18 in. required by the extractor. Figs. 6 and 7, on page 202, show piles in course of extraction.

ZINC IN GERMANY.—The last report of the large Hohenlohe works, with a capital of 80,000,000 marks, shows a far more satisfactory surplus than the two preceding years, the surplus for the year ended March 31, 1916, amounting to 4,959,016 marks, against 114,581 marks and 3,314,114 marks respectively for 1914–15 and 1913–14, and whilst no dividend was declared, a dividend of 6 per cent. has been declared for the last financial year. The writings-off and reserves for the last year and the two preceding years were respectively 6,500,000 marks, 9,223,000 marks and 6,020,000 marks. The demand for zinc varied a good deal during last year. The demand for coal was very active throughout the year, but scarcity of available rolling-stock interfered with deliveries. Prospects for this branch of the business seem favourable. The zinc works produced 24,953 tons of zinc during the year, against 23,825 tons in the previous year, and the zinc rolling mill-produced 5,292 tons of zinc plate. The production of coal amounted to 1,879,168 tons, against respectively 1,591,080 tons and 2,082,480 tons for the last two years. The prices for zinc continued to rise, the quotations of the Union of Zinc Works having been :—

Beginning of April, 1915 ...	57.75 marks,	against 48.25 marks in the previous year, corresponding period.
Beginning of July, 1915 ...	63.00 marks,	Ditto Ditto.
Beginning of October, 1915...	63.00 marks,	Ditto Ditto.
Beginning of January, 1916...	63.00 marks,	against 50.50 marks in the previous year, corresponding period.
End of March, 1916	66.00 marks,	against 57.75 marks in the previous year, corresponding period.

ELECTRICITY WORKS AND ICE WORKS.—In view of the present tendency of concentrating power utilisation by combining coal mining, electricity generation, and metallurgical works, &c., the suggestion of combining electricity works and ice works deserves attention. Artificial ice works are more common on the Continent than over here, and the electricity works of Steglitz (Berlin), and of Oberhausen (near Düsseldorf) have for four years been combined with local ice works. The capacity of these works is not large, 120 and 60 tons per day. In recommending such combinations, Dr. R. Pabst (*Elektrotechnische Zeitschrift*, January 20, 1916) estimated that electricity can be obtained for 6 pfennig per kw. hour (and less); water at 10 pfennig per cub. m., cooling water at 3 pf. (1 mark = 100 pfennig), and steam (for thawing the ice blocks in their iron cells sufficiently for removal) at 3 mark per 1,000 kg., when coal is 14 marks per ton. Thus 50 kg. of ice could be made for 38 pf. The sale should be left to some agent, who would be charged 45 pfennig. Allowing for depreciation, administration, &c., Dr. Pabst estimates that the ice works should pay more than 11 per cent.

COLONIAL ENGINEERING PROJECT.

We give below a few data on an Australian engineering project, taken from the *Board of Trade Journal*. Further information on this project can be obtained from the Commercial Intelligence Branch, Board of Trade, 73, Basinghall-street, London, E.C.

Australia.—The Sydney Office of H.M. Trade Commissioner in Australia has forwarded a copy of the specification, &c., in connection with a call for tenders by the New South Wales Department of Public Works for the supply and erection of power plant, transmission line, and aerial ropeway, for the Chichester River Storage Reservoir. Sealed tenders, on the proper forms, will be received by the Department named up to 2 p.m. on September 18.

COAL.—The exports of coal from the United Kingdom declined from 41,186,419 tons in the first seven months of 1914 to 22,379,578 tons in the first seven months of 1916, showing a decrease of 18,806,841 tons. In this decrease steam coal alone figured for 13,494,504 tons; anthracite for 308,833 tons; gas coal for 3,297,001 tons; household coal for 628,265 tons; and other descriptions for 1,078,238 tons.

CONTRIBUTION FROM SIAM FOR AEROPLANE.—The Foreign Office states that the British subjects of all races in Siam placed at the disposal of His Majesty's Government 2,250*l.*, on the second anniversary of the declaration of war, in order to purchase a fighting aeroplane, and add that they hope to provide another later. His Majesty's Government have asked the Minister at Bangkok to convey their expression of great gratitude for this generous gift, and have informed him that the aeroplane will bear the inscription: "Presented by British subjects of all races in Siam."

GERMAN ALKALI INDUSTRY.—The German Alkali industry has not shared in the average prosperous development of German industries, but has on the whole yielded unsatisfactory results. An instance of this is afforded by the concern called by a misnomer "Adolf's Glück"; it has been in existence for 10 years and has not yet paid any dividend. Last year has been particularly unsatisfactory, the loss on the year amounting to 213,396 marks, but the bank credit has during the year risen from 220,322 marks in the previous year to 731,078 marks, and the loan from the Hope mining concern was increased by 842,295 marks, now amounting to 939,353 marks. The share capital is 4,500,000 marks.

COMMITTEE ON FUEL ECONOMY AND SMOKE PREVENTION.—An interim report prepared by the above Committee will be presented and discussed at a joint meeting of the Chemical and Engineering Sections of the British Association at Newcastle-on-Tyne at 10.0 a.m. on Friday, September 8. The field of inquiry has been divided up among the following five sub-committees:—(1) Chemical and Statistical; (2) Power and Steam-Raising; (3) Metallurgical, Ceramic and Refractory Material Industries; (4) Carbonisation of Coal; (5) Domestic Consumption and Smoke Prevention. Each sub-committee has prepared an interim report, indicating the lines on which it proposes to work towards the preparation of a final report. In order that the discussion may be organised on the best possible lines in the time available, it is requested that any person wishing to take part should communicate with Mr. E. D. Simon, 20, Mount-street, Manchester, stating the particular aspect of the subject upon which he wishes to speak.

AMERICAN MACHINERY EXPORTS.—The great increase in exports recently reported from the United States is still continuing, the values for May being 21,984,961 dols., as compared with 10,214,062 dols. in May, 1915. Gasoline engines figured in the May total for 1,466,457 dols., as compared with 393,079 dols.; steam engines for 500,322 dols., as compared with 413,952 dols.; all other engines for 590,114 dols., as compared with 66,824 dols.; and parts of engines for 876,648 dols., as compared with 366,867 dols. The exports of metal working machinery in May were valued at 9,935,806 dols., as compared with 3,762,567 dols.; pumps and pumping machinery at 611,438 dols., as compared with 241,224 dols.; and type-writing machinery for 968,417 dols., as compared with 538,451 dols. The value of the sewing machines exported in May was, however, only 534,430 dols., as compared with 569,863 dols. In the eleven months ended May 31 this year the exports attained the following importance: Adding machines, 956,327 dols., as compared with 424,316 dols.; cash registers, 1,314,674 dols., as compared with 1,232,798 dols; elevating machinery, 1,367,567 dols., as compared with 752,467 dols.; gasoline engines, 9,734,480 dols., as compared with 3,932,045 dols.; steam engines, 13,265,351 dols., as compared with 2,570,700 dols.; all other engines, 6,407,301 dols., as compared with 2,574,005 dols.; metal working machinery, 52,849,047 dols., as compared with 24,427,406 dols.; milling machinery, 2,435,815 dols., as compared with 279,424 dols.; miscellaneous mining machinery, 5,722,740, as compared with 3,955,154 dols.; pumps and pumping machinery, 4,224,081 dols., as compared with 2,250,008 dols.; sugar-milling machinery, 5,589,716 dols., as compared with 1,922,278 dols.; textile machinery, 2,336,151 dols., as compared with 1,407,364 dols.; type-writing machinery, 7,990,138 dols., as compared with 4,521,364; and other machinery and parts of machines, 28,903,231 dols., as compared with 15,954,933 dols. The exports of mining machinery declined from 1,786,993 dols. to 1,183,790 dols. There was also a falling off in the exports of sewing machines from 5,659,396 dols. to 4,995,701 dols.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, August 16.

THE rush of orders for munition and material continues; recent orders placed by the Allied Powers call for 500,000 tons of billets, sheet bars, bars and forgings, to be delivered during the first half of next year. Large domestic orders are now being placed for steel to cover contracts which have been placed during the past two months calling for somewhere around 400,000 tons of steel to complete this contracted work. The locomotive concerns, the Midvale concern and the American Steel Foundries have contracted for over 200,000 tons of the above-mentioned quantity, and the Ford Motor Car Company is inquiring for 40,000 tons of fabricated steel for a number of automobile buildings at Detroit. The French Government have contracted for a tonnage of round bars calling for an immense quantity of material which will be made in Alabama, and an Eastern maker of munitions will furnish 50,000 tons of rounds for 6¼-in. shells for the British Government; other countries are in the market for rails, freight cars, locomotives, steel plate and other material; the order from Japan recently referred to calls for 28,000 tons of ship-plates, which will be enlarged by 10,000 tons. The Canadian Pacific will soon have closed for 50,000 tons of rails, France wants 3,000 freight cars; some unforeseen difficulties are still interfering with the final placing of 20,000 freight cars recently reported as having been definitely closed. The rail mills are so crowded with work that it is with difficulty that orders can be placed with delivery before next July; there is a continual scramble for ship-plates, and the estimated volume of inquiries is 60,000 tons to cover shipbuilding work, upon which estimates are being made; a great deal more tonnage is being anxiously inquired for than it is possible for shipbuilders to even consider; the entire market is characterised by feverish activity; considerable construction work, involving constructional material, continues to be held in check by war prices and structural material. Prices continue to show an upward trend in all lines.

STEELTON.—Mr. C. M. Schwab, president of the Bethlehem Steel Corporation, announced some time ago a contemplated expenditure by the Corporation of 15,000,000 dols. for the improvement of its Steelton plant. Improvements in blast furnaces and power plants are to be pushed forward to an early completion. The new contracts proposed also comprise additional coking plants, new rolling mills, and general electrification. A still larger expenditure, 20,000,000 dols., is contemplated by the Bethlehem Steel Corporation on its shops at Sparrow's Point, Maryland.

VACUUM SPECTROGRAPH.—The vacuum spectrograph described by Drs. Manne Siegbahn and Einar Friman, of the University of Lund, Sweden, in the *Physikalische Zeitschrift*, 1916, pages 176–178, was specially designed for the study of X-ray spectra on the lines of Moseley. The instrument is self-contained, the slit of 0.1 mm. width, the slide and the revolving table supporting the crystal to be examined and the photographic plate being placed within a cylindrical box of brass, 30 cm. diameter, 8 cm. high, 6 mm. wall thickness, which is evacuated with the aid of a molecular Gaede pump. A tube connects the box with the X-ray bulb, the rays passing through a perforated lead cylinder into the box. The salt to be studied is rubbed on the face of the antikathode of copper, which is filed off after each test; yet the spectrum of the last-used substance is always faintly visible in the subsequent test. The edges of the slit (of lead) are coated with gold. Having previously studied the K-lines of a large number of metals, Siegbahn and Friman examined with the new vacuum spectrograph especially the L-lines of the rare earths, pure materials having been placed at their disposal by Carl Auer von Welsbach. The important result of the investigation is that all the atomic numbers from 59 (praseodymium) to 73 (tantalum) are now filled up, with the exception of 61, and that these numbers are in agreement with the chemical determinations of the atomic weights of the respective elements.

THE TRADE OF WEI-HAI-WEI.—The trade of Wei-hai-wei, says the *London and China Telegraph*, has not suffered from the war as much as the merchants might have anticipated at the end of 1914. Exchange was against the import trade, which was also affected by the enhancement in the price of the chief articles of import, such as sugar, flour, cotton yarn, &c.; but there was a good export trade in groundnuts, groundnut kernels and groundnut oil, and this increase was due to certain places in Chinese territory situated beyond Taingtao having shipped their products to Wei-hai-wei instead of to the former port. The imports, it is not surprising to learn, showed a considerable decrease. The lack of shipping and high freights due to the war is sufficient to account for this. It is satisfactory to learn that the experimental farm established by the British-American Tobacco Company had a better year than during 1914. Afforestation is proceeding apace. The island, with the exception of the golf links, is now covered with fir trees, by which its appearance has been much improved. There is no regular afforestation staff, and such work as has been done has been carried out by Chinese coolies under the immediate supervision of the inspectors of police. It would also appear from the report that in most departments of the Administration progress is the order of the day. On the whole the government of our Chinese possessions is eminently successful. The natives are permitted to live their lives in their own way without undue interference, subject only to such restrictions as are necessary to enforce law and order.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

South Yorkshire Coal Trade.—The market has an irregular tendency, due in a large measure to the uncertain character of the export trade. Collieries are not able accurately to estimate for any lengthy time ahead the probable calls upon them in this direction, and this causes considerable variations in the quantities available for the home consumers. House coal continues in fair demand, and collieries are quite depleted of stocks. Delays are common, as private wagons are taking most of the production. Best hard steams remain very strong, and here, again, there are no stocks at pits. The inquiry both for home and export business is equally good, though considerable difficulties are experienced in the latter section through the scarcity of tonnage and the licensing regulations. Cobbles, nuts and slacks are freely sought, the latter having stiffened up somewhat during the last few days. Works and railways are eager to secure their winter reserves, and they are now being steadily built up. Blast-furnace coke still finds an excellent sale, at the full values. Prices for inland sales of all classes of fuel remain unchanged, but for the neutral trade there are repeated variations. Quotations:—Best branch hand-picked, 20*s.* 6*d.* to 21*s.* 6*d.*; Barnsley best Silkstone, 17*s.* 6*d.* to 18*s.* 6*d.*; Derbyshire best brights, 17*s.* 6*d.* to 18*s.* 6*d.*; Derbyshire house, 16*s.* to 17*s.*; best large nuts, 15*s.* 6*d.* to 16*s.* 6*d.*; small nuts 15*s.* to 16*s.*; Yorkshire hards, 16*s.* 6*d.* to 17*s.* 6*d.*; Derbyshire hards, 16*s.* to 17*s.*; best slacks, 12*s.* to 13*s.*; seconds, 10*s.* 6*d.* to 11*s.* 6*d.*; smalls, 8*s.* to 9*s.* per ton.

Iron and Steel.—There is a briskness in all departments of the Sheffield trade, and firms report they have more orders on their books than they can cope with for many months ahead. As a matter of fact, many orders have been declined. Finished goods of all descriptions meet an exceptionally good demand but, as in other directions, manufacturers are engaged upon the maximum output and cannot undertake further liabilities for immediate delivery. The activity prevails in the overseas as well as in the home trade. The British Colonies and neutrals are big customers for saws, edge tools, files, cutlery, spoons, forks, and all classes of manufactured steel. From the United States large orders arrive for the better qualities of cutlery and plate. A pressing need of files for Army purposes keeps this industry very busy, and a greater number of women are being drafted into the works to increase the output of the smaller sizes. Colonial and foreign trade for files, twist drills, milling cutters, reamers, boring tools, &c., shows a temporary slackness, but this is artificial and has been produced by the new regulations which require export licences to be obtained before consignments can be sent abroad. One effect is to add still further to the heavy burdens which have already fallen upon the clerical staffs. In the raw material market matters are not very satisfactory. During the last few days there has been a deadlock between makers and consumers. The maxima muddle is the cause of the trouble. The Derbyshire firms, who chiefly supply the Sheffield works with common irons, received a letter some little time ago from the Ministry of Munitions authorising them to charge an additional 5*s.* for foundry iron. In the official list which has just been published only the names of the Staffordshire, Lincolnshire, and Northamptonshire makers were mentioned as entitled to the increase, and nothing was stated of the Derbyshire, Leicester, and Nottinghamshire brands. Buyers desire to hold Derbyshire makers to this official list, and contend the maximum is 87*s.* 6*d.* as arranged under the first scheme, but the Derbyshire makers are ignoring this figure and demanding the full 92*s.* 6*d.* The result is, business has been at a standstill for some days, and there is no immediate prospect of the matter being cleared up. With regard to the other brands, it is worthy of note that there is a decreased tonnage of Lincolnshire foundry on offer, the reason being the greater efforts which are put forward to augment the supply of the much more wanted basic. Hematites are coming forward in bigger quantities, though the delivery of mixed brands still leaves room for improvement. The general consumption of steel-making irons is very heavy. Basic billets are very hard to obtain for all work outside munitions. The Government has invited makers to change foundry furnaces to basic iron, and the result is awaited with interest.

CUTLERY.—We have been doing pretty well this year in the matter of our cutlery exports, the value of the shipments for the seven months ended July 31 having been 369,305*l.*, as compared with 306,423*l.* in the corresponding period of 1915, and 451,428*l.* in the corresponding period of 1914. We may add that the value of the shipments for July was 65,493*l.*, as compared with 47,783*l.* in July, 1915, and 71,225*l.* in July, 1914. The United States are buyers of British cutlery to a fair extent, the exports to that quarter for the first seven months of this year being valued at 28,577*l.*, as compared with 21,843*l.* and 44,907*l.* Australia, however, is the great purchaser of British cutlery. The colonial demand for the first seven months of the last three years is indicated by the following values:—

Colonial Group.	1916. £	1915. £	1914. £
South Africa	39,461	34,656	35,814
British India	37,490	38,214	51,589
Australia	113,030	86,306	96,494
New Zealand	35,470	19,164	19,461
Canada	42,580	30,801	44,536

The imports of British cutlery into Argentina to July 31 were valued at 6,355*l.*, as compared with 6,874*l.*; those to France, at 10,379*l.*, as compared with 6,292*l.*; and those to Brazil, at 9,334*l.*, as compared with 11,384*l.*

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-iron Market.—Still there is no evidence of any resumption of business in the Glasgow pig-iron warrant market, and meantime the stocks in store remain at or about 1,000 tons.

Sulphate of Ammonia.—At a meeting of the Central Executive Committee of the National Farmers' Union of Scotland held at the end of last week, a reply from the Fertilisers Committee regarding the future supply of sulphate of ammonia was submitted, and after some discussion it was decided that the attention of all the different branches should be directed to the present conditions upon which supplies could be obtained. Agriculturists generally present at the conference convened by Lord Provost Sir Thomas Dunlop are taking the matter up with much spirit.

Scotch Steel Trade.—Both last week and this a large percentage of the local steelworkers have been on holiday, the sectional system having given the experiments on entirely satisfactory results. The temporary cessation of activity has permitted of a considerable amount of necessary repair work being undertaken. Industrial conditions, therefore, have shown a slight slackening off, although by the end of this week it is confidently expected that it will be "full steam ahead" once more. Throughout the entire width of Scotland the production of war material—steel bars for shells, sections and plates for the Admiralty—forms the bulk of the output, so that it was only in cases where heavy repairs were necessary that the works were closed, this being avoided wherever possible by letting the employés off in sections. Without hesitation one may say that the demands of Government will continue unabated so long as the war lasts, the requirements being as insistent as ever. As in every other branch of trade, export business to neutral countries is practically at a standstill, the Government restrictions being stringently enforced. Prices are firm, and any change will be a further advance. Ship plates remain at 15*l.* per ton and up; boiler plates, 16*l.* net, f.o.b.; and angles, 14*l.* 5*s.* or thereabouts.

Malleable Iron Trade.—Little change falls to be noted in connection with the malleable iron trade—makers continuing to be busily employed upon Government contracts to the almost complete exclusion of ordinary mercantile business. During last week quite a number of works took holiday on the sectional plan, but now all are fully started up again, and the greatest activity prevails. Makers are finding it increasingly difficult to supply other than a few sizes of bar iron, and in consequence a certain stiffening of prices seems inevitable, but although this will affect export it will not likely make much change in the home market. For export "Crown" bars are now quoted 14*l.* 5*s.* per ton f.o.b., and up, according to grade, while the home rate remains steady at 14*l.* 12*s.* 6*d.* less 5 per cent.

Scotch Pig-iron Trade.—The continued demand for pig-iron of all grades, particularly for hematite, is responsible for the remarkable amount of business which is being put through, nor is there any appearance of the least easing off, and as quickly as it can be produced the entire output of hematite is taken up by the local steelworks doing Government work. Meantime, however, foundry iron, especially the No. 1 brand, becomes daily scarcer, and it is with difficulty that supplies can be obtained. There is no present indication of any lowering of price. Unless where supplies of pig-iron are required for the Allies, export trade may safely be said to be non-existent.

Munition Workers' Holidays.—Following the issuing of the report of the Government Committee charged with the consideration of the relay system of holidays for munition workers generally, Mr. Arthur Henderson, M.P., who was appointed Chairman of the Committee, has just circulated a very strong appeal urging that compliance with the finding of the Committee be rigidly adhered to. Mr. Henderson, while emphasising the fact that the Committee had decided that to grant holidays in relays was practically impossible, expresses the view that the members were thoroughly agreed that a week-end rest for munition workers is absolutely essential. He points out, however, that the exigencies of the war require a rigid adherence to the recommendation of the Ministry of Munitions, and that in fixing the earliest possible date on which workers may be freed for a brief holiday the Committee has taken every possible phase of the matter into most earnest consideration. Like the Commander-in-Chief himself, the Committee is deeply appreciative of the valuable assistance rendered by the munition workers, both on the Clyde and elsewhere throughout the country, and feels assured that the present appeal will not be lightly regarded by any one.

AUSTRALIAN RIVERS.—As compared with other countries, New South Wales has few inland waterways, being dependent upon railways and ocean shipping as the principal means of transportation. On the coastal rivers of the State there is some traffic apart from vessels trading between the river ports and Sydney; but the extent of this traffic is not known. On the inland rivers there is a considerable traffic after a season of good rainfalls. The Murray is navigable for about 150 miles above Albury, or 1,590 miles from its mouth. Its tributaries, the Kyalite and the Wakool, are navigable for some 400 miles, as far as Deniliquin. The Murrumbidgee and the Lachlan provide 900 miles of navigable waterway. The Darling is navigable in times of freshets as far as Walgett, 1,758 miles from its confluence with the Murray. Altogether the Murray system provides 4,200 miles of waterway more or less navigable.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Under the conditions prevailing, business in Cleveland pig-iron must be regarded as on a fairly good scale, though with iron unpurchasable for the last quarter of the year operations are confined to arrangements for September supply. Rather considerable sales have been made to Scotland. Local consumers are well bought, and are receiving supplies with satisfactory regularity. For home consumption No. 3 Cleveland pig, No. 4 foundry, and No. 4 forge all stand at 87*s.* 6*d.*, and No. 1 is put at 91*s.* 6*d.* It is stated that No. 3 is obtainable at 95*s.* from makers for shipment to France, but the generally recognised export quotation is 97*s.* 6*d.* No. 1 is quoted at 102*s.* 6*d.*; No. 4 foundry, 96*s.* 6*d.*; and No. 4 forge 95*s.* 6*d.* for shipment abroad.

Stocks of Cleveland Pig-iron.—Stocks continue to be steadily drawn upon. The quantity of Cleveland pig-iron in the public warrant stores here now stands at 16,447 tons, composed of 16,061 tons of No. 3 quality, and 386 tons of other kinds of iron deliverable as standard. Since August 1, 7,369 tons of No. 3 have been withdrawn, and 16 tons of standard iron have been added—a net decrease of 7,353 tons.

Hematite Iron.—Conditions in the East Coast hematite branch of trade are not favourable to new business. Producers are fully sold to the end of the year, and it is very difficult to arrange new contracts. Hope is entertained that the output will be increased before long by the blowing in of additional furnaces. In the meantime allocations are made in such a manner as to meet all essential home requirements, and the needs of our Allies are dealt with according to urgency. For home consumption and for shipment to France Nos. 1, 2 and 3 stand at 122*s.* 6*d.*, but there are consumers in France quite prepared to pay up to 142*s.* 6*d.* for any odd lots merchants may have held previous to the control period. For general export mixed Nos. are quoted 140*s.* and upward.

Shipments of Pig-iron.—Shipments of pig-iron from the port of Middlesbrough may be regarded as satisfactory. Clearances to France are on a good scale, and a few parcels are going to Italy, but the latter is drawing most of her supplies from America. With a day's loadings yet to add, shipments for August are returned at 52,252 tons. The total clearances for July amounted to 54,311 tons, and the despatches for August last year were officially given at 43,098 tons.

Coke.—Owing to curtailment of shipments, there is a very ample supply of coke to meet the heavy local demand. Quotations show no change. Average blast-furnace kinds continue readily to realise 28*s.* at the ovens, and up to 30*s.* 6*d.* at the ovens is asked for qualities low in phosphorus.

Foreign Ore.—Business in foreign ore is practically at a standstill, due to consumers having large and steadily accumulating stocks, and consequently not being disposed to make further purchases. Heavy supplies are coming regularly forward, the imports to the Tees for August against running contracts being in the neighbourhood of 225,000 tons. Sellers are not at all disposed to lower prices. With rubio, of 50 per cent. quality, round about 21*s.* f.o.b. Bilbao, and steamers from that port to the Tees commanding 18*s.* 6*d.* in the open market, the ex-ship Tees price of best rubio ore should be 39*s.* 6*d.*, but the recognised market quotation is 38*s.* on the basis of the official 17*s.* Bilbao-Middlesbrough freight, the rate at which controlled consumers continue to be privileged to arrange conveyance of the ore.

Manufactured Iron and Steel.—As regards the finished iron and steel trades, manufacturers are still too busily occupied with Government work to pay much attention to ordinary commercial business. Quotations are well maintained. Common iron bars are 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; double best bars, 14*l.* 10*s.*; treble best bars, 14*l.* 17*s.* 6*d.*; iron ship plates, 13*l.* 10*s.* to 14*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 17*l.* 10*s.* to 18*l.* 10*s.*, according to diameter; packing iron and steel (parallel), 10*l.*; packing iron and steel (tapered), 12*l.* 5*s.*; steel bars (no test), 14*l.* 10*s.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel ship rivets, 20*l.*; steel hoops, 16*l.* 10*s.*; steel strip, 17*l.*; steel joists, 11*l.* 2*s.* 6*d.*; heavy sections of steel rails, 10*l.* 17*s.* 6*d.*; and steel railway sleepers, 12*l.*

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE.—The lectures on railway and cognate subjects at this school, session 1916–17, will commence on Thursday, October 5. Courses of lectures on other subjects are also announced. A series of inaugural lectures also takes place from October 5, dealing with the war and after-war problems. Full particulars may be obtained from the Secretary, Clare Market, Portugal-street, Kingsway, W.C.

A 204-IN. ROLLING MILL.—The Lukens Iron and Steel Company, Coatesville, Pennsylvania, have recently installed a rolling mill capable of producing finished plates 192 in. wide. The rolls are 204 in. long by 34 in. in diameter. The largest mill in Europe is said, by Mr. A. F. Huston, president of the Lukens Company, to be that at Witkowitz, in Hungary, which has 178-in. rolls, and the largest in Great Britain are, according to the same authority, the 168-in. rolls at Dalzell's steel works. The new mill will provide plates up to the limit of transport possible with the present loading gauge of the American railways.

NOTES FROM THE SOUTH-WEST.

Cardiff.—Only a restricted business has been passing in steam coal at Cardiff, week-end influences and scarcity of supplies rendering new transactions difficult. There has been no indication of the heavy requirements of the authorities being modified; on the contrary, recent pressure appears likely to continue. The best Admiralty large steam coal has been, to some extent, nominal; secondary qualities have made 41*s.* to 42*s.*; Monmouthshire Black Veins, 41*s.* 6*d.* to 42*s.*; ordinary Western Valleys, 41*s.* to 41*s.* 6*d.*; Eastern Valleys, 39*s.* to 41*s.*; best bunker smalls, 29*s.* to 30*s.*; and cargo smalls, 20*s.* to 25*s.* per ton. In bituminous coal, best households have made 25*s.* 6*d.* to 28*s.* 6*d.* at the pits; No. 3 Rhondda large, 37*s.* to 38*s.*; smalls, 29*s.* to 31*s.*; No. 2 Rhondda large, 33*s.* to 35*s.*; and No. 2 smalls, 23*s.* to 24*s.* per ton. The latest quotation for patent fuel has been 45*s.* to 50*s.* per ton. Special foundry coke for export has brought 62*s.* 6*d.* to 65*s.*; good foundry coke, 50*s.* to 52*s.* 6*d.*; and furnace coke, 50*s.* to 55*s.* per ton.

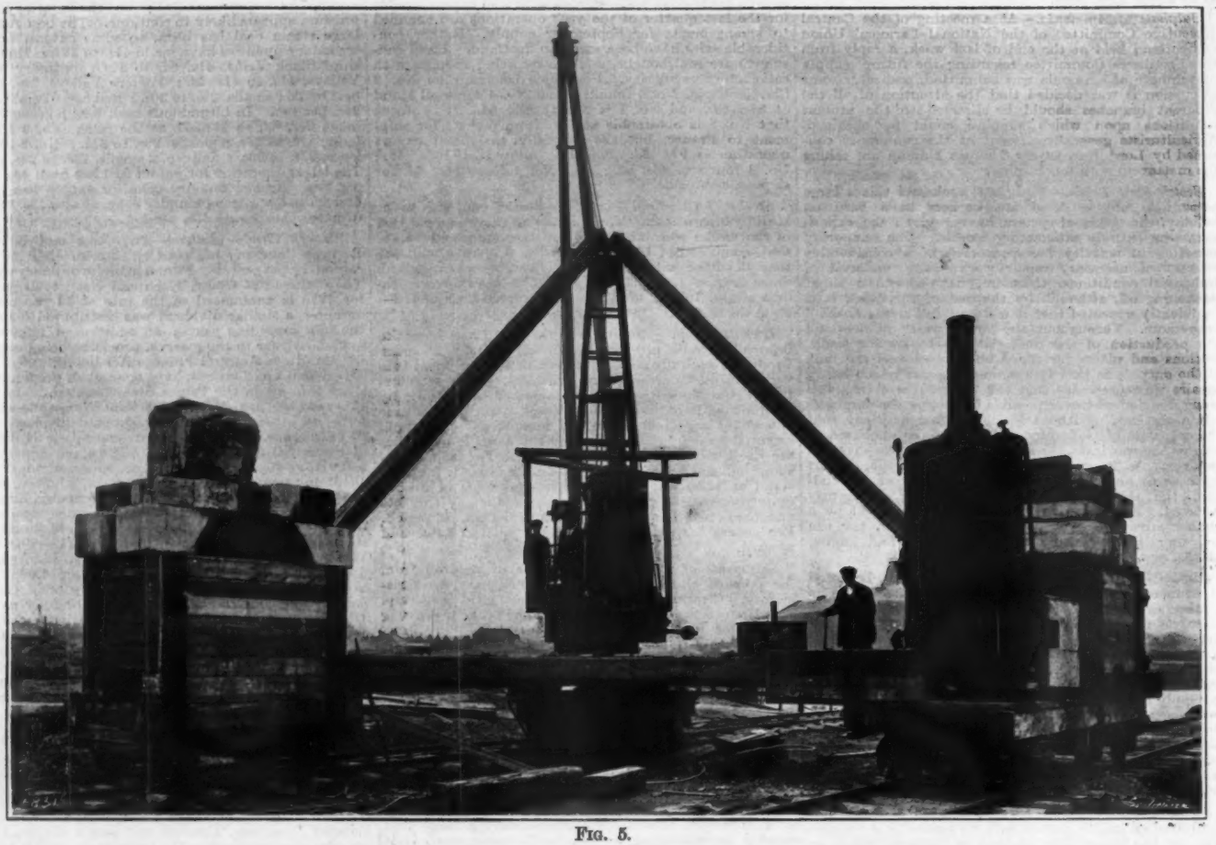
Western Trade Matters.—The Ross and Monmouth Railway Company has paid an interim dividend at the rate of 1¾ per cent. per annum upon its ordinary shares.—The dividend of Guest, Keen and Nettlefolds, Limited, for 1916 is announced at the rate of 15 per cent. per annum; a similar dividend was distributed for each of the four preceding years; an addition of 100,000*l.* was made last year to the reserve, provision being also made for Munitions Act and Finance Act liabilities.—Furness, Withy and Co., Limited, have acquired a preponderating share interest in the Prince Line, Limited. The Prince Line, whose registered office is at Newcastle-on-Tyne, owns 42 steamers with an aggregate displacement of 275,520 tons. Its authorised capital is 1,000,000*l.*, of which 601,405*l.* is paid up.—The steamship Prophet, 5,700 tons deadweight, built at Newcastle-on-Tyne in 1912, and owned by Evans and Reid, Limited, Cardiff, has been sold to the Mitre Steamship Company, Limited.—The steamship St. Nicholas, 6,300 tons deadweight, built at Sunderland in 1901, has been sold for 80,300*l.*; she was sold for 25,000*l.* in March, 1914.—The Bristol Wagon and Carriage Works Company, Limited, pays 5 per cent. for the past financial year, 4,990*l.* being carried forward.—The Astley and Tyldesley Collieries pay dividends of 15*s.* per share upon the fully paid and 12*s.* per share upon the partly paid ordinary shares for the past 12 months, 5,000*l.* being added to the reserve and 5,862*l.* carried forward.—The final profits of the Fernhill Collieries Company, Limited, for 1915–16 are returned at 44,874*l.*, as compared with 28,500*l.* in 1912, 43,990*l.* in 1913, 32,008*l.* in 1914, and 39,085*l.* in 1915 (provision being made for excess profits duty). The dividend for 1916 is at the rate of 20 per cent., as compared with 16 per cent. in 1912, 1913 and 1915, and 10 per cent. in 1914.—The Bedwas Navigation Colliery, Limited, has decided to pay an interim dividend of 6 per cent. per annum upon its preference and 10 per cent. per annum upon its ordinary shares; the Bedwas is a new undertaking.—The Penarth Harbour Dock and Railway Company, Limited, will pay a dividend of 5¼ per cent. September 6.—The tonnage of vessels entering Milford Docks in the past half-year amounted to 408,120 tons gross and 201,174 tons net, as against 183,895 tons gross and 199,169 tons net in the corresponding six months.—A cargo of maize recently arrived at Bristol from the Argentine Republic; the amount of the invoice was 69,273*l.*, of which the maize only accounted for 18,826*l.*, the remainder being represented by freight.—The London and Northern Steamship Company has been bought up by Messrs. Pyman, Watson and Co., Cardiff. The company's fleet consists of 16 steamers of about 92,000 tons deadweight. The company has hitherto been managed by Messrs. Pyman Bros., Limited, Bishopsgate-street, London, and it is understood that these offices are to be continued. Messrs. Pyman, Watson and Co. have considerable interests in steamers, as well as in South Wales collieries. They are large coal factors, while they carry on an extensive ship-broking business. Mr. Pyman is a director of the Cardiff and Newport Patent Fuel Company, Limited, the Ffaldan Collieries Company, Limited, the Port Talbot Graving Dock and Shipbuilding Company, Limited, the Pyman Steamship Company, Limited, and the Raithwaite Steamship Company, Limited. Mr. Watson is similarly associated with a number of local concerns.—At the half-yearly meeting of the Aberdare and Abermman Consumers' Gas Company, the chairman (Mr. D. P. Davies) said the war had now occasioned an advance of 70 per cent. in the price of coal, while the increase which had been established in the price of gas was only 14 per cent.

MILLWRIGHTS' SPEED AND POWER CALCULATING SCALE.—We have received from Messrs. Alfred Haworth and Co., Limited, 84, Leadenhall-street, E.C., a specimen of a new special slide rule intended for millwrights' use. It enables the pulley diameters and belt sizes for different speeds and powers to be obtained directly. The rule is made of cardboard and is clearly printed. It is sold at 1*s.* 6*d.*; sent post free for 1*s.* 8*d.*

TRAFFIC ON THE RHINE–HERNE CANAL.—The canal section Rhine–Herne was finished just before the war. It forms one of the side links of the Rhine–Elbe canal and is to relieve the railway load. During the year 1914 goods aggregating 650,000 tons passed through this canal, more than half of this bulk being coal. During 1915 this figure rose to 3,300,000 tons. The traffic would have been greater still, after supplying improved facilities for the loading and unloading, &c., if the lock had operated more speedily.

PILE-DRAWING AT THE SITE OF THE THAMES IRONWORKS.

(*For Description, see Page* 198.)



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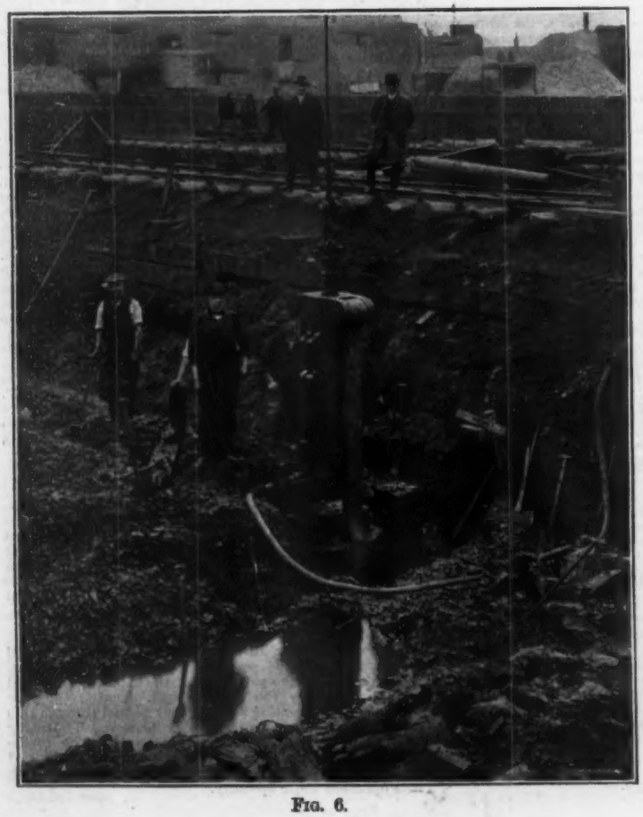

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FIG. 7.

DETAILS OF FRAMES FOR LOCOMOTIVES, CLASSES "K4S" AND

MR. J. T. WALLIS, GENERAL SUPERINTEN

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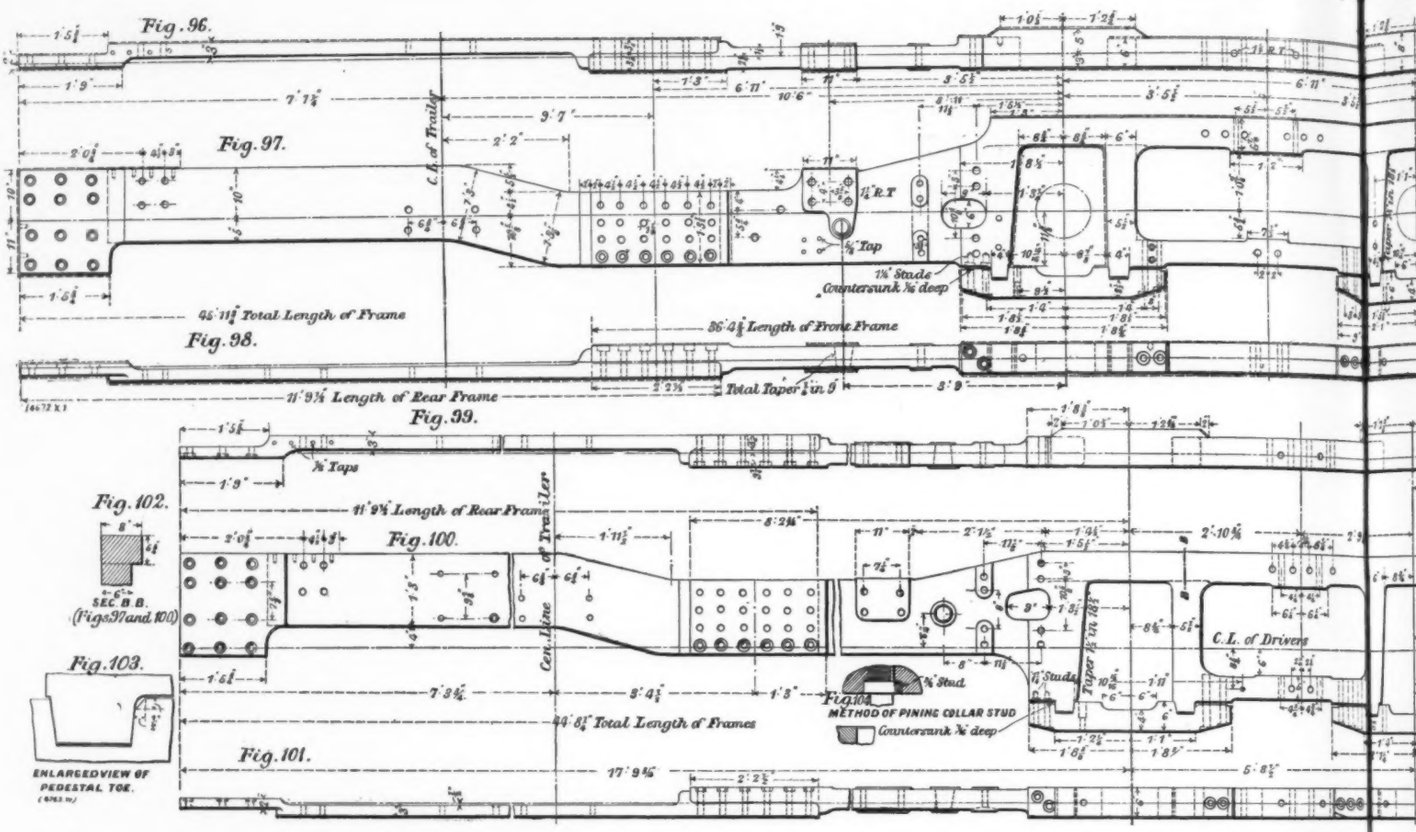

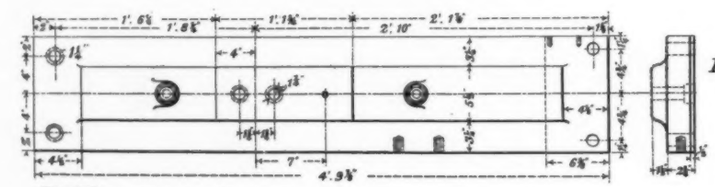

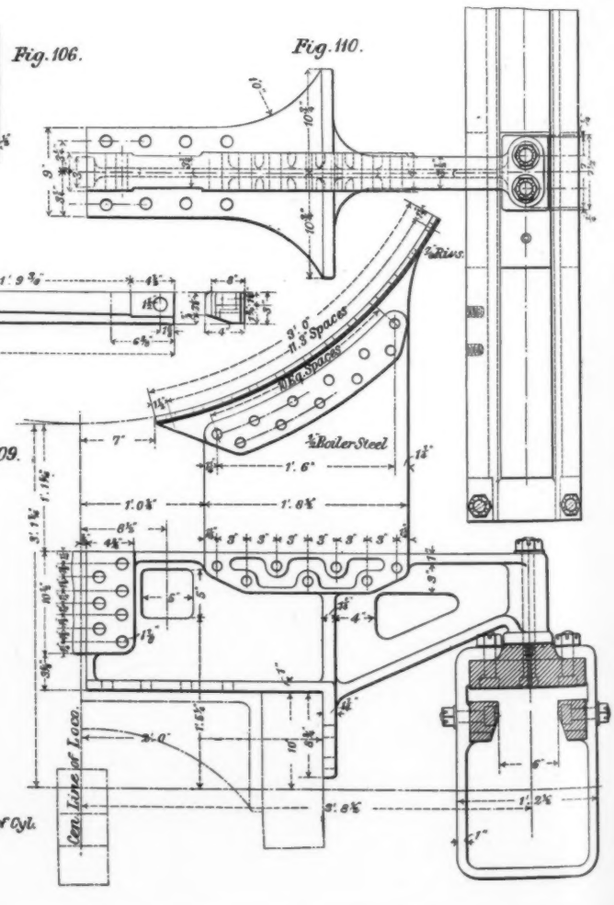

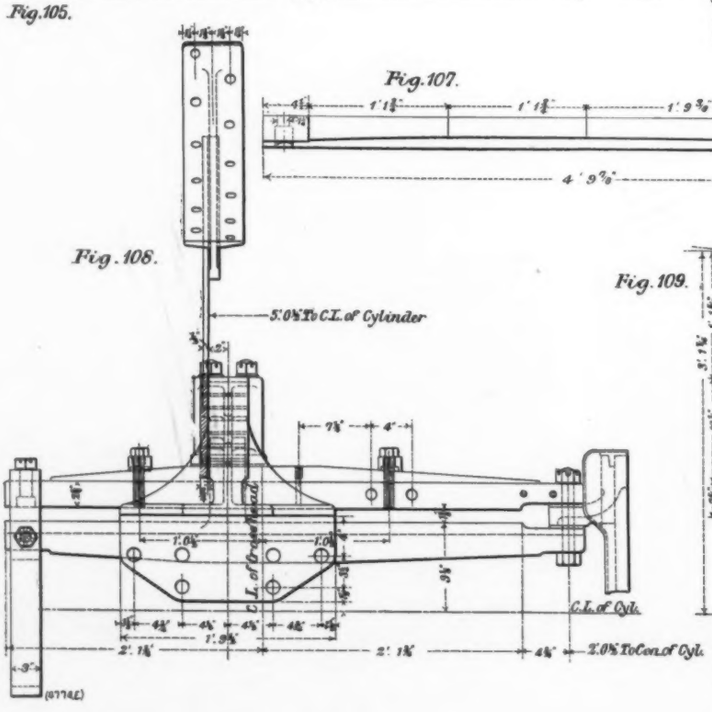

ND "L1S," FOR THE PENNSYLVANIA RAILROAD COMPANY.

L SUPERINTENDENT OF MOTIVE POWER.

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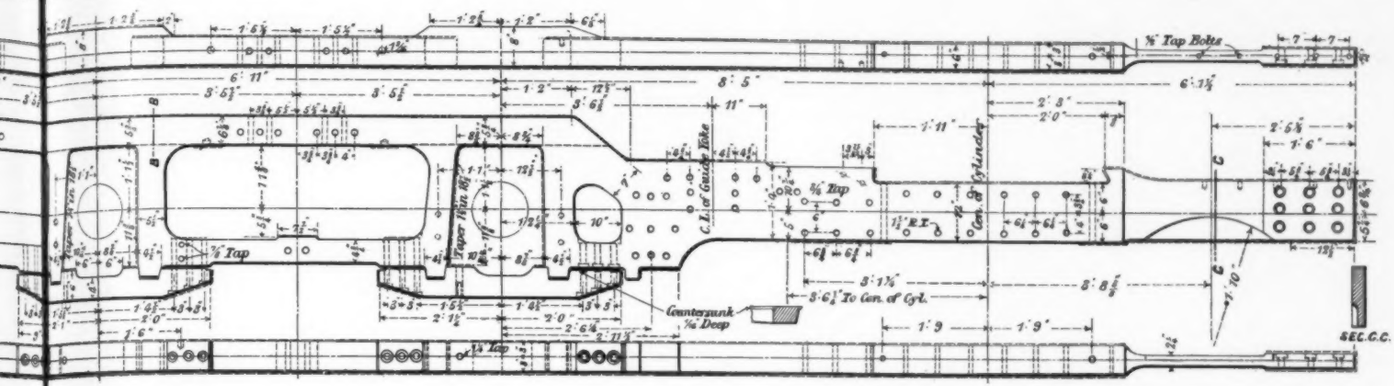

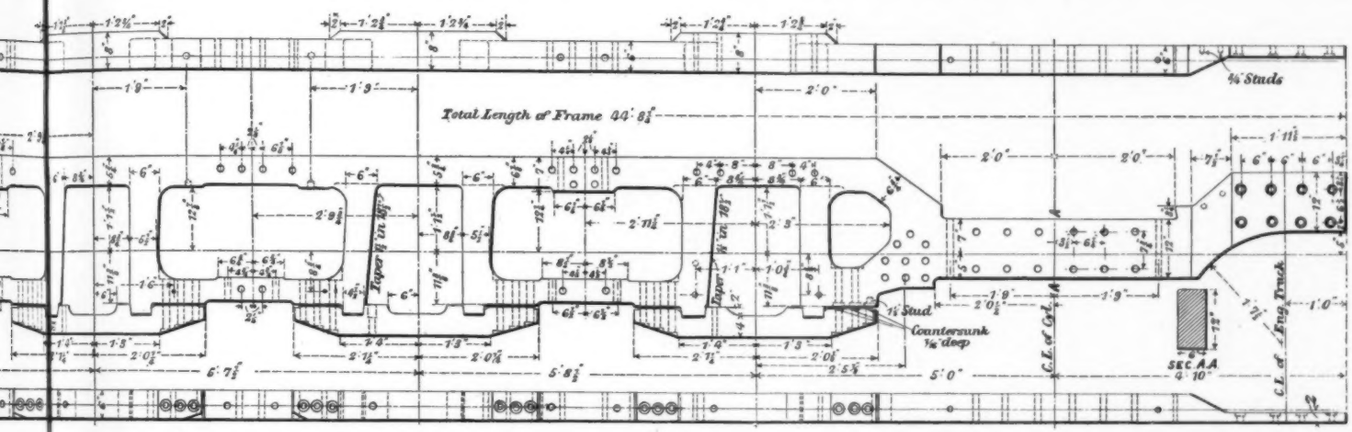

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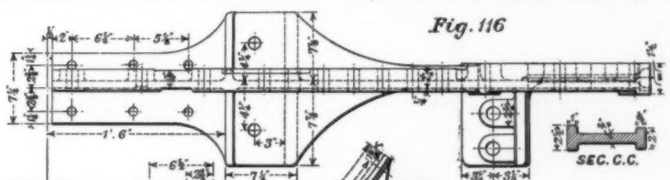

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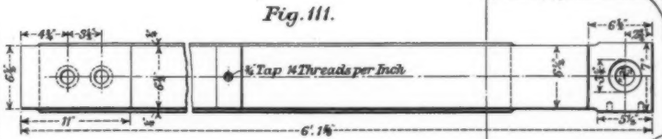

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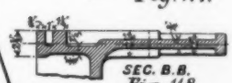

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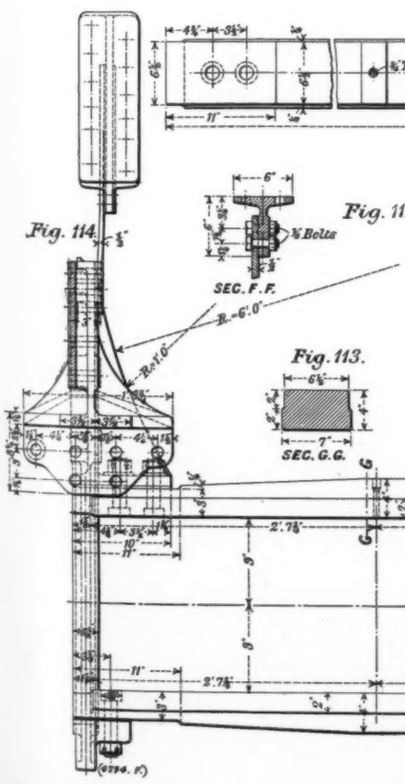

Fig. 112

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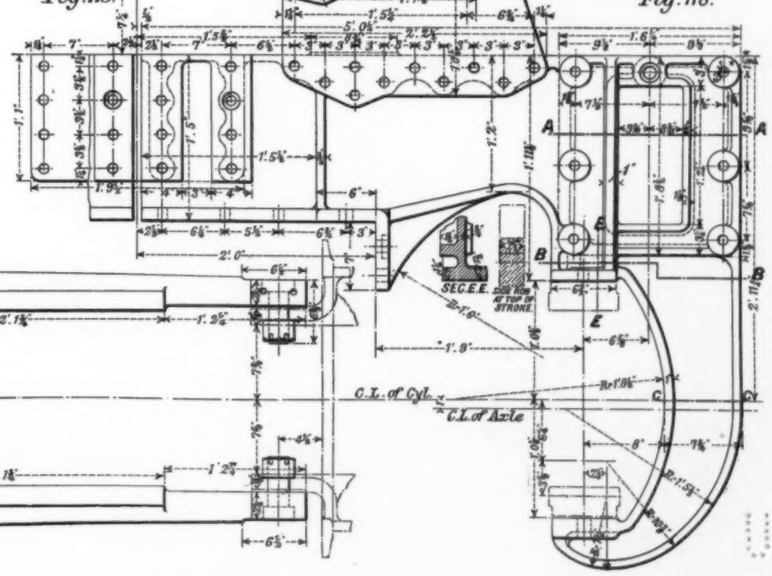

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The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages seven words. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

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"ENGINEERING" may be ordered from any Newsagent in town or country and at railway book-stalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

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Foreign and Colonial subscribers receiving incomplete copies through newsagents are requested to communicate the fact to the Publisher, together with the agent's name and address.

All accounts are payable to "ENGINEERING," LIMITED. Cheques should be crossed "Union of London and Smith's Bank, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford-street, Strand, W.C.

Offices for Publication and Advertisements, 35 and 36, Bedford-street, Strand, London, W.C.

We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—3063 and 8598 GERRARD.

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With a Two-Page Plate of the DETAILS OF FRAMES FOR LOCOMOTIVES, CLASSES "K4S" AND "L1S," FOR THE PENNSYLVANIA RAILROAD COMPANY.

NOTICE OF MEETING.

THE INSTITUTE OF MARINE ENGINEERS.—Tuesday, September 5, at 7 p.m. Presidential Address by Sir James Mills, K.C.M.G.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

ENGINEERING.

FRIDAY, SEPTEMBER 1, 1916.

ROAD TRAFFIC.

THE development of highway traffic is probably of greater importance in this country than in most others, in view of the very short average length of haul. With short hauls terminal charges, especially when these involve a transhipment from one class of vehicle to another, constitute a large fraction of the total costs. This fact is frequently forgotten when comparisons are made between ton-mile charges by rail in America, Germany, and in this country. Unfortunately many writers on such questions do not realise that a thorough understanding of the statistics of any industry is impossible to anyone not intimately acquainted with it in detail. As a consequence the aphorism that there is "nothing so fallacious as facts, except figures," finds daily exemplication in the effusions of many popular writers on economic questions. Rail charges in this country are no doubt high when reckoned per ton-mile, but as the average haul is short, these charges are responsible for only some 12 per cent. of the total costs of distribution.

Since, however, heavy mineral traffic carried at very low rates is included in this average, the burden is undoubtedly in many cases much heavier than this figure would convey. As a consequence we have had ardent advocates of a great extension of our canal system, but in this country, with no great internal natural waterways to be coupled up by relatively short lengths of artificial channels, it is difficult to make out a plausible case for the policy. Much more is to be hoped from the further development of mechanical traction on our highways, although provision for this will necessitate, no doubt, a very heavy capital expenditure. To carry really heavy and fast traffic, the road foundation should be about 10 in. thick, whilst, as a matter of fact, a large proportion of the 235,000 miles of our roadways have no proper foundation at all. The capital expenditure which would be necessary to bring up the whole of the main-road mileage to the high standard desiderated has been estimated at between 250 and 300 millions sterling.

Hopes have been held out that the ultimate result of this expenditure may not necessarily be a permanent increase in the annual cost of our roadways. In certain cases this would appear to have been realised, as Mr. J. S. Brodie has stated that the 89 miles of roadway under his control at Blackpool cost 74.83*l.* per mile per annum in 1906, whilst owing to the reconstructions he has since effected the cost fell to 43·06*l.* per mile in 1915. The figures for the country as a whole are, however, much less promising. According to the report of the Road Board* just issued, the expenditure on road maintenance, in the case of English and Welsh boroughs, rose from 1,967,620*l.* in 1908–9 to 2,416,642*l.* in 1913–14. The corresponding figures for country districts are 6,241,088*l.* and 8,099,011*l.* respectively. In spite of the great cost of making streets in towns fit for the heavier traffic, the expenditure per head of population, it may be noted, is not much more than one-third of what it is in the country districts. Of course in connection with these figures it must be remembered that a very large mileage of highway is now traversed by traffic far in excess of the strength of the roadway, and maintenance costs are thus exceptionally heavy. In such cases, as at Blackpool, reconstruction would sensibly reduce the annual charges.

In contrast to the estimated capital expenditure needed for the complete reform of our highways the 7,250,000*l.* so far raised by the Road Board appears almost insignificant, but of course local authorities were also investing largely in road improvements until the fateful August of 1914. Considerations of national policy have now put a term to the floating of municipal loans, save for exceptional reasons, amongst which road reconstruction has not commonly been included. It has further been decided to cease the payments hitherto made to the Road Board out of the sums received by the Treasury from petrol and motor carriage licenses, so that, for the present, the sole income of the Board is derived from the interest on their accumulated funds. Indeed, the Retrenchment Committee, in their report issued last September, advised that no further grants at all should be made by the Road Board for highway improvements whilst the war lasted, but on pressure from the local authorities this recommendation was withdrawn in favour of another by which the aggregate of the new grants and loans made is limited to 200,000*l.* for the year 1916–17. The amount the Road Board have to their credit still available for such grants is about 2,500,000*l.* As stated, all receipts from the Treasury have now ceased, so the income of the Board, which amounted to 1,620,974*l.* in 1915, will, it is estimated, be reduced during the current year to 135,000*l.*, of which 97,000*l.* will be required for the costs of administration. The Treasury payments to the Board, it should be noted, were drawn entirely from the motor spirit duties and from the licences. The former brought in 898,041*l.* in 1915 and the licences 630,325*l.*

Though its income has been so seriously reduced the Road Board continues to do most valuable work. Its organisation has proved of the utmost utility to our Military and Naval authorities and to the Ministry of Munitions. On their behalf the Board has supervised the construction and maintenance of many miles of new road. It has, further, on behalf of the same departments, arranged with highway authorities for the improvement of certain public roads to suit military needs, and has also settled the amounts payable by the Army Council for damage caused by the extraordinary military traffic. In all, for the three departments named, the Board has superintended the expenditure of over a million sterling. In certain cases where improvements made on behalf of the military were at the same time overdue on behalf of the ordinary requirements of the highway, part of the cost has been borne by the local authorities.

The Road Board have, moreover, continued their experiments in road-making, the advantage of which will be reaped when normal conditions are restored. There have been repeated instances of roads constructed—nominally, at any rate—to the same specifications giving very different results in practice. Materials which have stood well as laid by one authority have gone to pieces in no time when used elsewhere. A knowledge of the why and wherefore is obviously of the utmost importance, and it is accordingly very desirable that this period of enforced inactivity in actual road reconstruction should be utilised to the fullest in determining the factors which lead to unexpected failures. A small expenditure now on experimental work may mean the saving of millions later on. This is fully realised by the Road Board, which has continued during the year the experiments with their road machine. The apparatus is under the control of the National Physical Laboratory. It consists of a circular concrete track 2 ft. wide and 34 ft. in diameter. This forms a foundation on which samples of the bituminous carpets used to take the wear of macadam roads can be laid. The surface thus prepared is subjected then to a heavy rolling load imposed by an eight-wheeled vehicle or frame, the speed of which can be varied from one mile per hour upwards.

The wheels are 3 ft. 3 in. in diameter by 3 in. wide, and each is independently driven. In the main test, made generally at a speed of 6 miles per hour, the load imposed is equivalent to 470 lb. per inch of tyre width, but in a first preliminary run, made to consolidate the carpet, the speed is reduced to 1 mile per hour and the load increased to about

* Sixth Annual Report of the Road Board. London: Wyman and Sons. Price 6d.

TABLE SHOWING RESULTS OF TESTS OF ROAD SURFACES MADE AT THE NATIONAL PHYSICAL LABORATORY.

			9	10	11	12
Test No.			—	—	—	—
Particulars of Material			—	—	—	—
Make of Bitumen			—	—	—	—
By whom Laid			—	—	—	—
				Bituminous Sand Carpets	*using Residual Bitumen.*	
			Mexphalte	Mexphalte	Aztecphalte	Aztecphalte
			Highways Construction Company	Sutton (Surrey) Urban District Council	Essex C.C. and Messrs. Constable, Hart and Co.	Messrs. Constable, Hart and Co.
Composition of Mixture	Proposed	Bitumen per cent.	13	13	10.8	14
		Filler per cent.	14.5 (Portland Cement)	20 (Portland Cement)	4.05 Blue Lias Lime	8 (Portland Cement)
		Sand per cent.	72.5	67	85.15 (Sand and Limestone Dust)	78 (Sand and Limestone Dust)
	By analysis	Bitumen per cent.	12	11.75	12	14
		Sand and Filler per cent.	88	88.25	88	86
Grading of Sand and Filler		Passing 200 mesh sieve	15	10	5	14
		,, 100 ,,	16	7	7	8
		,, 80 ,,	13	4	10	7
		,, 50 ,,	25	33	68	50
		,, 40 ,,	8	25	8	13
		,, 30 ,,	7	2	1	1
		Retained on 30 ,,	16	10	1	7
Method of Mixing			Batch Mixer	Batch Mixer	Batch Mixer	Mastic Mixer
Temperature of Mixing		Deg. F.	380	340	295	500
Temperature of Laying		Deg. F.	260–350	210–325	200–260	325–415
Method of obtaining Consolidation			Tamping and smoothing	Tamping and smoothing	Tamping and smoothing	Tamping and smoothing
Amount of Consolidation			Considerable	Considerable	Small	Considerable
Result of Test	Consolidation Stage (slow speed)	Tons per yard width	4,550	4,716	5,370	6,144
	Wet Stage (6 m.p.h. approximately)	Tons per yard width before excessive vibration	212,100	124,700*	25,960	458,200
Deformation of Surface obtained from Sections of the Test road		During Consolidation Stage	0.02 in.	0.00 in.	0.12 in.	0.03 in.
		During Wet Stage	0.08 in.	0.07 in.	0.07 in.	0.05 in.
		Total	0.10 in.	0.07 in.	0.19 in	0.08 in.
		Per cent. Deformation on original Thickness of Surface	5.6	4.7*	12.7	5.3
Specific Gravity		When Laid	2.10	2.11	1.82	1.97
		At conclusion of Test	2.12	2.13	1.94	2.08
		By calculation (voidless)	2.28	2.31	2.24	2.21
Per cent. Consolidation			1.0	0.9	6.6	5.6
Per cent. of Voids		When Laid	8.6	9.5	23.1	12.2
		At conclusion of Test	7.5	8.5	15.5	6.25
Absorption of Water		Per cent.	2.5	2.6	7.4	†

* Not including test after patching. † This test is still proceeding.

750 lb. per inch width of tyre. As representing the most trying condition possible the roadway is kept wet throughout the whole run and the temperature is maintained at about the summer average, as bitumens are then in a softer condition. The test is continued until the roadway has become so rough that the vibration is excessive.

Particulars of the results of four tests are given in the report and are summarised in the annexed table. The differences of the wearing qualities of carpets of nominally the same construction are, it will be seen, very great, and are particularly striking in the case of tests Nos. 11 and 12. Here the carpet failed completely in test No. 11 after a traffic of but 25,960 tons per yard of width; whilst in the next test, with not very great changes in the materials, 458,200 tons were carried. Four causes are suggested for the failure in the first case, viz., an unsuitable mixture, the filler being insufficient; too low a temperature of laying: insufficient initial consolidation; and too small a percentage of bitumen. In the second test it is noted that the method used in mixing the material was slow and not that usually employed in practice, but if any considerable proportion of the enhanced life is due to this it would be cheaply gained even if the labour cost were much greater than usual. The report further states that the temperature of mixing and laying was also higher than customary.

Although the discrepancy is less in the case of experiments 9 and 10, yet it is still very considerable, the one surface having nearly double the life of the other. An attempt was made to extend the life of the surface in test No. 10 by patching, but although the patches held the roadway failed elsewhere. With good carpets the surface, it is stated, remains smooth and polished until the traffic taken exceeds 200,000 tons per yard width; wave-like markings then appear and extend until the surface becomes so rough as to cause excessive vibration.

Of course it is not maintained that the conditions of road traffic are exactly reproduced in this machine. Indeed, experience at Paris some years since showed that surfaces from which horsed traction was entirely excluded wore much better than much less heavily travelled streets over which the traffic was of a mixed character. Nevertheless the indications obtained from the machine are probably relatively correct and show with reasonable accuracy the comparative values of different materials and methods of construction.

INDUSTRIAL RESEARCH.

IT is commonly admitted that many of the arts of peace have originated in the necessities of war. The sword may conceivably be ultimately beaten into a ploughshare, but the very possibility is evidence of the precedence of the weapon over the implement of peace. The wonderful awakening of the nation to the necessity of a vast improvement in our educational and industrial methods gives hope that even in the almost overwhelming cataclysm of to-day we may once again find "some soul of goodness in things evil." It is at least noteworthy that prominent labour leaders have publicly admitted that certain of the trade union restrictions of the past were neither ethically nor economically defensible, and similarly it is to be hoped that employers have learnt that high rates of wages need not necessarily imply high labour costs. Again, firms have in the national interest been ready to interchange dearly bought knowledge and experience, and the spirit of co-operation thus started may do much to facilitate the schemes for scientific and industrial research which are now being promoted by the Advisory Council for Scientific and Industrial Research appointed last year.

The first report of this Council has now been issued, and shows that much research work likely to be of permanent advantage to the nation is in progress. Some of it, of course, was undertaken to supply immediate necessities due to the war. For example, out of 100 kinds or more of optical glass, but a couple of dozen varieties were hitherto made in this country, and there was an equal dearth of the special glasses used for apparatus in physical and chemical laboratories. Magnetos were practically wholly imported, and but one-tenth of the dyes needed for our textile trades were of domestic origin. Zinc, again, though smelted largely from ores originating within the Empire, was almost wholly obtained from sources under German control. Various special kinds of pottery were also imported, and, moreover, the Seger cones used for regulating the furnace temperatures in our own potteries were also obtained from Germany. On the outbreak of hostilities much inconvenience arose accordingly in many industries from the failure of former sources of supply. Perhaps, however, the most remarkable feature of the situation was the relative ease and rapidity with which it was remedied. In the case of chemical glassware, for example, matters at one time appeared so serious that the Board of Education took a census of all the chemical glass available in the educational establishments of the country with a view to commandeering it should the necessity arise. The Glass Research Committee set up by the Institute of Chemistry, however, soon eased the situation by providing manufacturers with the requisite detailed data for the production of a number of these special glasses, and the work is now being continued with the help of the Advisory Committee. The Seger cones needed by the potters were soon supplied by Dr. Meller, Principal of the Stoke Pottery School, and porcelain of a quality suitable for chemical ware and combustion tubes is now being made by Messrs. Doulton and by the Royal Worcester Porcelain Company. Of course, the deficiency of dyestuffs is still far from being made good, but this matter is one of no extraordinary urgency.

The war has undoubtedly had a great educative effect on those set in authority over us. When the National Physical Laboratory was founded the maximum assistance the Treasury was prepared to promise was a contribution of 4,000*l.* for a period of five years. This has since been raised to 7,000*l.*, which appears almost insignificant when contrasted with the 100,000*l.* per annum received from the United States Government by the Bureau of Standards at Washington. Fortunately the relative incomes of the two institutions are in no way indicative of the relative value of the work done. There would indeed appear to be in such matters a law of diminishing returns comparable with that held to apply to investments of capital in new industries. Later investments, it is maintained, never receive the same returns as were reaped by the successful pioneers, but this fact has never been held as an argument against the fullest possible development of an industry, and the same rule will apply to expenditure on industrial research.

Whilst the National Physical Laboratory, as stated, had to be content at its inception with the small grant mentioned above, the Advisory Committee had at their disposal last year 25,000*l.*, a sum which for 1916–17 will be increased to 40,000*l.* The figure is still well below the Washington precedent, but the progress is marked.

The Council have decided for the present, at any rate, to devote the whole of their resources to the promotion of applied science, this field being that in which this country has long been somewhat backward. In part it would seem that the Council hope, by striking object lessons, to convince manufacturers of the value of a better-trained and larger technical staff. The business man looks for immediate returns. The existing generation of works proprietors cannot personally benefit by the proposed reforms in our system of secondary education, and the only hope of maintaining their interest is to prove that applied science may be immediately profitable. This accomplished, the business man may later on be prepared to face the long delays and disappointments which must be met with in such an investigation as that which made the synthesis of indigo a commercial proposition. This research lasted twenty years, and its patient prosecution reflects the highest credit on the scientific faith and insight of those responsible for financing it. As matters stand, our manufacturers, as is well said in the report, seek to find in science not a partner, but a handy servant. The results are naturally disappointing. An instructive

example has been cited recently by Professor Armstrong, who was able to date the decay of one of our great firms of manufacturing chemists from the time when the skilled chemist was reduced to this status of handy servant, whereas during the previous long period of prosperity one of the three partners was himself a chemist of standing.

Of course such a prolonged research as that which resulted in the commercial production of synthetic indigo could only be financed by a very rich and prosperous corporation. It is impossible for us to start at this stage, but the report suggests that the difficulty may be overcome by the co-operative action of a large number of small firms. In the case of problems of a simpler nature each would naturally conduct its own researches independently, but the more difficult problems would be dealt with by the industry as a whole and in the interests of all. Some industries have already united in this way for commercial ends, such as the regulation of prices, and it is suggested that a similar course might be taken in connection with the more difficult and abstruse problems in applied science. Something of this kind has already been done. The Staffordshire pottery manufacturers are, as a body, promoting experiments in order to develop the manufacture of hard porcelain, so as to compete in this product with German and Austrian manufacturers, and they hope thus to build up a new and probably remunerative trade in this material in place of the cheaper sorts of bone china. Similarly the Textile Institute is promoting an investigation at Leeds University on the electrification of fibres. On the other hand, the manager of a large rubber manufacturing company is reported as unwilling to support an "academic" research into the constitution of rubber. This instance well illustrates the difficulties which have to be overcome in making leaders of industry realise the fact that the ultimate result of fundamental researches of this type may be vastly more important industrially than investigations directed to an immediate practical end. Indeed, firms are far too often content with a more or less empirical solution of an immediate difficulty, with the result that little is learnt as to how trouble is to be avoided in the future.

The Council, in their report, emphasise the importance of a much larger supply of scientifically trained assistants, but the difficulty hitherto has been to find suitable employment for the relatively small number which have left our technical colleges in the past. We are strongly of opinion that the sole hope of liquidating without distress the enormous war debt now being piled up will lie in a very large increase in the "thinking" departments of our industries. One difficulty in the past has been the accountant's little pleasantry of classing such departments as non-productive, and another has lain in the inevitably highly speculative character of all experimental work. With the low average rate of return on industrial capital which has ruled here for many years past, it has only been exceptionally prosperous firms which have felt justified in undertaking ventures of this kind.

After the war, capital—being able to receive 4½ per cent. to 5 per cent. on Government security—will not be forthcoming for the financing of our industries unless the average return is to be substantially higher than has hitherto ruled, and with this higher return there may perhaps be a greater readiness to face the heavy cost and risk of experimental work. This will, in its turn, render easier the earning of the higher rates of interest which will be demanded.

CONTINENTAL SHIPBUILDING AND SHIPPING DEVELOPMENT.

NEVER before in the history of shipbuilding and shipping has such extraordinary activity prevailed on the Continent. The old shipyards are being extended and new ones formed, shipping companies are being started almost every day, old concerns increase their capital, vessels keep changing hands at fabulous prices, and harbour extensions to accommodate this new traffic are the order of the day. If all these undertakings can be gauged by the share list they are as many gold mines.

In Holland, throughout Scandinavia, and in other countries shipbuilding yards are provided with work for years to come, and new concerns are being started under the best possible auspices. At Kallundborg, in Denmark, a new shipbuilding company has just been formed. The corporation is filling up a portion of the fjord and letting the area for building purposes to the new company for a period of 50 years, and a floating dock will also be constructed. A large new local shipping concern, started for running sailing vessels, has decided to have six steamers, of 2,000 tons each, built at the new yard, and in their fleet six large sailing vessels are to have motors installed. Not the least interesting feature in the present feverish movement is the revival of the sailing ship. But many authorities are extremely sceptical as to the future of the sailing vessel and discourage its renaissance.

Swedish shipping concerns and Swedish yards are equally well employed. The largest steamer so far built in Sweden has just been launched at the Göta yard, Gothenburg. It is the Skagern, with a capacity of 8,000 tons, ordered by the Swedish Transatlantic Steamer Company, and intended for the Australian trade. The keel was laid on January 5, 1916, and the boat is expected to be ready about November. A Swedish consular report urges the desirability of cultivating the Australian traffic, since the United States and Japan are doing their best to develop their direct connections with Australia. Another Swedish shipping company which is greatly extending its fleet is that of the Nords German, which has six motor vessels in course of construction in Copenhagen, each of 6,450 tons, and three motor vessels in Gothenburg, each of 9,200 tons. The new vessels are intended to increase the company's traffic to Brazil, La Plata and on the Pacific coast. Sweden has, on the whole, shown much enterprise and initiative of late years in extending her oversea shipping, and the value of her exports overseas, to Asia, Africa and America, rose from 13,570,670 kr. (760,000*l.*) in 1905 to 44,692,275 kr. (2,500,000*l.*) in 1913. The Swedish Government is also assisting shipping by loans and other ways, and is contemplating serious endeavours for keeping the North Swedish ports open beyond the usual time when ice stops the traffic. A number of ice breakers are being built for that purpose, and an expenditure of 25,000,000 kr. is considered necessary in order to keep shipping going for an extra month beyond the usual time.

Large new harbour works and extensions are going on or approaching their realisation in all three northern kingdoms. The plan for the Malmö free harbour has now been finally drawn up, and is calculated to entail an expenditure of 9,360,000 kr. (522,000*l.*). The area for the free harbour is situated to the north-east of the present harbour, and the entrance is to be through the present inlet, 80 m. broad, by way of the eastern channel, both of which are to be deepened to 9.25 m. (30 ft. 4 in.). The basins of the new harbour are to have the same depth, and will comprise an outer harbour, 80–200 m. broad and about 400 m. long, and a basin east of the former, 100 m. broad and 500 m. long. The water area will be 33 acres and the land area 53 acres, the length of quay being 1,860 m. (6,200 ft.). All the quays are to be built of concrete, faced with granite. There will be one stationary 25-ton crane and seventeen 5-ton movable cranes.

In Norway the question of a free port is also to the fore, and of late Stavanger has come into prominence as the most favourable position, with convenient access from the sea, entailing very little loss of time. Further, Stavanger is at no great distance from the large English coal mining districts, and it is conveniently located for transit, both to other Norwegian ports and to Archangel and the Baltic. Norway's largest dry dock is at present being constructed at Stavanger, and additional railway facilities will establish connection between Stavanger and Christiania.

Russia, in spite of the war, is exerting herself in no small degree to meet the after-war competition in shipping. Russian yards, both on the Baltic and the Black Sea, have been considerably extended during the war, in addition to which a large new shipyard is being constructed on the Murman coast. The Russian steamer companies, however, have not confined themselves to the home yards in the matter of new ships, having placed orders both with Swedish and Norwegian yards, in the same way as vessels are being built for Russian account in Japan, both at the Osaka yard and the Kavasaki yard.

Holland has no doubt materially improved her merchant navy during the war by selling old vessels and building new in their place, at the same time as the Dutch yards have built a number of vessels for foreign account. As in other countries, an improvement of harbour and canal facilities has followed in the wake of the shipping boom. The course from the Hook of Holland to Rotterdam is to be or is being enlarged. There will be constructed a third Ymuiden lock, and the waterway from Ymuiden to Amsterdam will be widened and deepened so that the biggest steamers may get as far as Amsterdam.

THE SPERRY SEARCHLIGHT.

IT is not very long ago that the belief was entertained that the searchlight had attained its maximum development. It was held that the boiling-point of carbon marked the greatest temperature possible in the arc, and that this fixed the illumination possible. Up to a certain point increase of current was attended by increase of light, but a maximum was soon reached beyond which further current made little difference. About the end of 1914, however, the Beck searchlight was introduced and marked a great advance. In it the arc is surrounded by an atmosphere of burning alcohol, which, of course, burns at a much lower temperature than carbon melts. The alcohol flame keeps the oxygen from the carbons, and at the same time cools the outer portions, which only waste the heat. Burning alcohol has a temperature of about 1,000 deg. C., which is below the natural temperature of the outer part of the arc. Carbon boils at about 4,000 deg. C., but it begins to evaporate at about 1,800 deg. C. The positive carbon in the Beck light is cored with a rare earth having a melting-point of 3,500 deg. C. It is quite possible, however, that in the ordinary arc the boiling carbon is obscured by a cloud of carbon evaporated at a lower temperature from the area surrounding the top, and that in the Beck arc this evaporation does not take place owing to the atmosphere of burning alcohol at a lower temperature. The true arc is then seen unobscured.

In the Sperry searchlight, an illustrated account of which appears in the current issue of the Journal of the United States Artillery, published at Fort Monroe, Virginia, an attempt is made to provide a more intensely luminous source than the boiling carbon. To this end the positive carbon is cored with "certain special materials that are powerful light producers." What these are is not stated, but it is not likely that they can have a higher boiling-point than carbon. Probably they are some of the rare earths which have a high luminosity, and this effect is increased by impeding their escape from the crater. This crater is very deep, and the vapour is pressed back into it by the arc flame from the negative carbon. This emanates at a very considerable velocity and beats back the escaping gases, so that the crater is kept full of them.

The improvement lies in an increase in the specific brightness of the light, which is the brightness per unit area of the light source. The pure carbon crater has a fairly constant brilliancy of 150 c.p. per square millimetre, while the candle-power of the dense positive vapour in the deep crater of the Sperry arc is stated to be 500. The corresponding figure for the sun at 30 deg. elevation is put at 775. When mounted in a United States 36-in. searchlight lamp the carbon arc gives 42,000 c.p. throughout a comparatively small zonal angle, while the Sperry arc under similar conditions gives 105,000 c.p. In the latter case the source of light is very small, as the deep crater has a smaller mouth area than hitherto possible with a pure carbon arc of similar amperage. The optical advantages of this are well known, for the angle of spread of the beam is materially reduced, and the beam made much more nearly parallel. For the standard 150-ampere arc the diameter of the positive carbon is ⅝ in., and that of the negative $\frac{7}{16}$ in. The wear of the positive carbon is large, because the gas escapes in spite of the flame from the negative carbon, and has to be renewed all the time. The carbon is therefore very long, being 44 in. for the standard 150-ampere lamp. The method of regulation

adopted in the Sperry lamp is interesting. The positive carbon is, of course, fixed horizontally opposite the parabolic mirror. The negative carbon is at a small angle to the horizontal, so that it intercepts comparatively few rays between the crater and the mirror, its smaller diameter being an advantage in this respect. Both electrode holders are cooled by air driven by a fan in the base through the electrode carriers. The air supplied to the positive holder is forced between a number of heat-radiating discs which surround the end of the holder nearest the arc. The positive carbon is continuously rotated to centre the arc, and its feed is regulated by a thermostatic device. This device is mounted in the interior of the drum which carries the mirror, and is so arranged that when the positive carbon burns out of the focal point of the mirror the light from its crater is brought on to the thermostat. Solenoids and a motor in the base, under the control of the thermostat, then feed the positive carbon until the focal point is again reached. The feed of the negative carbon is controlled by another solenoid connected directly across the arc; the carbon is moved in the proper direction as the voltage rises and falls.

Searchlights of 24, 30, 36 and 60-in. diameter are being made by the Sperry Gyroscope Company, and their development will be followed with much interest. The lesson of the war is that artillery, to be effective, must be able to act at great distances. But to do so the object must be visible, either to the gunners or to the observing officer, and at night this is only possible by aid of artificial illumination. Zeppelins must be illuminated before they can be shelled effectively, the periscopes of submarines are invisible at night until they come into the beam, a crippled ship runs great risk of being torpedoed unless she can pick up the boats at a considerable distance, and so on. There are conditions—atmospheric and otherwise—in which success in attack, or escape in danger, depends largely upon being able to see the enemy from afar, and therefore every improvement in searchlights is an addition to the offensive and defensive power of the country that possesses it. Possibly the United States will guard the secret of the Sperry lamp as an advantage to the Navy which it is setting itself so resolutely to build up.

PARIS INTER-URBAN TRAFFIC AND THE WAR.

WITH reference to our recent articles dealing with this same subject and with the construction of the Paris motor 'buses* we may state that notwithstanding the large amount of military work it is carrying out, the French General Omnibus Company has succeeded in building a few motor 'buses for service on the well-known Grand Boulevards, a busy Paris thoroughfare which is not directly served by any of the Underground lines of the Paris Metropolitan Railway. This furnishes the occasion for giving a few data on the Paris urban traffic during the year 1915, a year which was entirely occupied by the war, and during which there were no omnibuses in service.

It might have been supposed that the war, the absence of a very large proportion of the male population of Paris and its suburbs, the fear of raids by German dirigibles and aeroplanes, and the bad state of trade would have exerted a most marked influence upon traffic in the French metropolis; as a matter of fact, the difference between normal conditions and those in 1915 is not so great as might have been expected, owing in part, and very fortunately so, to a recovery in business. In regard to circulation in the open, the only vehicles of the General Omnibus Company available were the electric tramways, and the results obtained by giving a longer and a closer service have been remarkable. Thus, the daily number of tramcar-kilometres, which fell to 24,600 (15,200 car-miles) on August 2, 1914, from 87,000 (53,800 car-miles) a week previously, rose gradually to 67,100 (41,500 car-miles) in May, 1915, and to 72,000 (44,500 car-miles) in December, 1915. (At the present time the total exceeds 77,000 (47,500 car-miles).) It should be borne in mind that these results have been obtained in spite of staff difficulties, the training of new hands, including 1,100 women conductors and the recruiting of over 2,000 operatives for work in several of the company's factories. It is clear that the absence of the company's motor 'buses, to the number of about 1,000, has led to a considerable fall in the receipts. In the year 1913, when the full number of motor 'buses was not yet in service, the company's passenger receipts amounted to about 58,000,000 francs (2,320,000*l.*); they fell to 20,500,000 francs (820,000*l.*) in 1915. The number of passengers carried was, respectively, 426,500,000 and 166,500,000. The average receipt per ramcar-kilometre exceeded 85 centimes (1*s.* 1*d.* per car-mile) in 1915. If the period from August 2, 1914, to December 31, 1914, be compared with the corresponding period of 1915, there will be found for the latter an increase of 40 per cent. in the number of tramcar-kilometres run, of 41 per cent. in the number of passengers carried and of 37.5 per cent. in total receipts.

The situation of the company has further improved owing to over 5,500,000 francs (220,000*l.*) of additional receipts for war work. But notwithstanding this, the fact that the total receipts have fallen so enormously at a time when the company had just completed the electrification of its tramway system and had just completed also a successful type of motor-'bus, leading to a first cost expenditure of some 160,000,000 francs (6,400,000*l.*), including 47,000,000 (1,880,000*l.*) for tracks, aerial and conduit mains, and over 7,000,000 francs (280,000*l.*) for sub-stations and high-tension mains, places the company in a very unsatisfactory situation.

The gross receipts for 1915 make a total of 26,186,000 francs (1,047,440*l.*) and the expenditure a total of 18,260,000 francs (730,400*l.*), leaving a balance of 7,926,000 francs (317,040*l.*). Out of this latter sum, 4,500,000 francs (180,000*l.*) have been distributed as interest to the bondholders who supplied funds for the new plant; about 1,500,000 francs (60,000*l.*) have been assigned in writings-off and a small dividend, 10 francs per share has been paid. Each share is of 500 francs, and the share capital is 83,000,000 francs (3,320,000*l.*). The company is a very strong one; its property in the shape of land, plant and buildings is worth about 53,000,000 francs (2,120,000*l.*) and covers an area of about 570,000 sq. m. (6,135,700 sq. ft.).

The underground system of the Paris Metropolitan Railway Company has not suffered so much as the General Omnibus Company since, unlike the latter, it has not been deprived of a large number of vehicles. The war has, however, had for effect to delay the working of a new underground line, from the Opera to the Palais Royal, which, although a short one, will prove most profitable, since it is to form an easy connection between the lines to the north of the French metropolis and the principal underground line from the Bois de Boulogne to Vincennes. Service on this new line commenced a few weeks ago; it completes the original underground railway system, which now has a developed length of 79 km. (49 miles) and was commenced over 18 years ago. The new underground system is to have a length of about 40 km. (25 miles); several of the lines are in construction, but progress is very slow owing to lack of labour and scarcity of materials. The underground railway rolling-stock consists of 703 motor coaches and 270 first-class and 335 second-class trailer carriages. Most of the carriages have been fitted with a mechanical door-closing device in view of a decrease in the staff.

The number of railway tickets issued in 1915 was 281,500,000; it was 312,000,000 in 1913 and fell to 268,000,000 in 1914. The distance run in 1915 was 54,290,000 km. (33,600,000 miles), as against 60,253,000 (37,000,000) in 1914 and 73,203,000 (45,000,000) in 1913. There were less vehicles in circulation in 1915, and those in the service travelled with more passengers than at the close of 1914. The average daily number of car-kilometres was only 133,000 (82,500 car-miles) in January, 1915, as against 214,000 (133,000 car-miles) in January, 1914; in August, 1915, the number exceeded 149,000 (92,500 car-miles), as compared with 69,000 (42,000 car-miles) in August, 1914. At the close of 1915, the figure was 157,000 (97,500 car-miles), as against 127,000 (78,000 car-miles) in December, 1914.

A proof that the situation on the Paris underground railway is improving is afforded by the fact that during 1915, the year being entirely covered by the war, the net receipts have been practically the same as those of the year 1914, five months only of which formed the war period. The net total receipts for the year were 11,000,000 francs (440,000*l.*), equal to about 142,000 francs per kilometre (9,140*l.* per mile). The receipts per kilometre on the Paris underground system have greatly fallen quite apart from any exceptional influence; the figure was 212,000 francs (13,645*l.* per mile) in 1908, it decreased to 193,000 francs (12,420*l.* per mile) in 1911 and to 188,000 francs (12,100*l.* per mile) in 1913. This is due to the constant development of the system and to transfer tickets from one line to another by means of which passengers now travel over a longer distance for a given rate.

In 1915, the number of first class tickets was 10.23 per cent. of the total, yielding 14.86 per cent. of the total receipts; the corresponding figures for second class were 68.25 per cent. and 59.45 per cent., and for return tickets 21.49 per cent. and 24.97 per cent., the two latter figures being much below those for the year 1913, showing that there were, in 1915, many less operatives to take advantage of return tickets in travelling to and from their work.

In 1915, the gross receipts reached a total of about 46,000,000 francs (1,840,000*l.*) and expenditure a total of 20,000,000 francs (800,000*l.*). The net financial result would have been better than it was had not all classes of material risen in price; the expenditure on coal alone exceeded by about 3,500,000 francs (140,000*l.*) the figure for the years preceding the war.

The Paris Metropolitan Railway Company has to pay heavy sums to the City of Paris, both in consideration of the work of installation carried out by the town on borrowed moneys and in the shape of an indemnity for the concession granted to the company. In 1915, after payment of the debenture interest, the placing of a sum to reserve account and to the sinking fund, and remunerating the directors, a total sum of 3,900,000 francs (156,000*l.*) was distributed to the shareholders.

The Nord-Sud electric underground railway commenced running about five years ago. It was a difficult line to build and it has felt the complications arising from the state of war. The share capital is 75,000,000 francs (3,000,000*l.*) and the debenture capital about 70,000,000 francs (2,800,000*l.*), on which no interest was paid in 1915, the small balance of net receipts over expenditure having been placed to the reserve account. In the case of this line also, the increase in the cost of coal has been a most serious item. The gross receipts for 1915 amounted to 9,577,000 francs (383,000*l.*) and expenditure to 5,438,000 francs (217,500*l.*). The interval between the trains has gradually been reduced, and the service is being carried out in good conditions, over more hours per day than in the latter part of 1914, deficiencies in the staff being gradually made good.

* See ENGINEERING, vol. c., page 474, and vol. ci., pages 343 and 419.

NOTES.

THE DIELECTRICS OF RADIOTELEGRAPHIC ANTENNÆ.

IN 1911 Messrs. C. Fischer and L. W. Austin found that the curve representing the variation of the antenna resistance with the wave-length of the oscillations had two characteristic features. Starting with the wave-length corresponding to the fundamental of the antenna, the equivalent resistance of the antenna was observed to decrease rapidly to a minimum, as the wave-length was increased, and then to rise again less rapidly. The first decrease followed a square law and was explained by a diminution in the energy radiated in the form of electro-magnetic waves as the waves became longer. The second increase in resistance followed a linear law and could not be accounted for. Resuming this research later, Austin was struck by the apparent similarity between this "linear increase" and the behaviour of an absorbing condenser. Noticing that the increase was less marked on ship stations than on land stations, he concluded that the earth acted as an imperfect dielectric, the antenna forming the upper plate and

the ground water the lower plate of a condenser, and that the ground thus caused this noteworthy resistance increase in land stations. His observation that the radiotelegraphic station at Arlington, in Virginia, which has an exceptionally good earth, also gave a very slight increase with increasing wave-length seemed to confirm this assumption. But other facts were not compatible with this suggestion of the earth behaving like an imperfect dielectric. The linear increase persisted at the high frequencies and short wave-lengths of telephones, whilst the measurements of Zenneck, Reich and True showed that even for a high frequency corresponding to a wave-length of 1,000 m. the magnitude of the conduction current was a hundred times greater than that of the displacement current. Moreover, condensers in which the air between the plates was partly replaced by clay behaved like perfect condensers with a series resistance which was independent of the frequency—except when the clay was very dry; in this latter case there was some absorption. Taking up these problems at the Washington Bureau of Standards (Scientific Paper No. 269), Mr. John M. Miller, in conjunction with Messrs. Rosa and M. James, arrived at the conclusion that the linear increase is indeed due to imperfect dielectrics, but that the absorption does not take place in the ground, as Austin assumed. It is apparently poor dielectrics such as wooden masts, trees, buildings and insulators of inferior dielectric properties in the electric field of the antenna, especially at points where this field is strong, which are responsible for the linear increase or absorption. This was established by arranging antennæ circuits in various ways so that the absorption by the ground, if taking place, would either be intensified or diminished, and in other experiments by introducing imperfect dielectrics into the circuit, running the wires near or through trees, or bringing the lead wires to an antenna inside a building. The effects thus produced were sometimes very strong, so that the conclusion appears justified, although one might perhaps object that the ground may sometimes play a part after all, as Austin had suggested. In any case the results are important, as they prove that many antennæ may be much improved as radiators. The capacity through wooden masts, trees, buildings and insulators should be made extremely small in comparison to the capacity of the antenna through unobstructed air. There should be no imperfect dielectrics near the antenna, trees and buildings should be far off, and the interior walls of rooms into which the leads to the antenna are taken should be covered with well-earthed metal screens. There is, or was, little agreement as to the exact part which the earth plays in radiotelegraphy, and this research is a contribution to this problem.

The Hardness of Metallic Alloys.

We noticed recently* the experiments made by Professor P. Ludwik on the changes in the internal friction of metals with temperature. He is now engaged in researches concerning the relations between the composition or constitution of alloys and their hardness. These relations are little understood; it is not as a rule possible to predict the hardness of a new alloy, and it must be admitted that, on the whole, the technological properties of alloys have not yet received much systematic study, though, of course, the Alloys Research Committee and other bodies and investigators have done very useful work. The conception of hardness is in itself indefinite; hardness is connected with a complex of other properties and changes, in metal testing, *e.g.*, both with temperature and with the rate of loading. The relation between hardness and atomic concentration has been studied by Benedicks, Traube and others. Benedicks found that, when equi-molecular weights of different metals were dissolved in iron, these additions affected the electric resistance and the hardness of the metal in similar ways. But it is not known in how far this holds for other solid solutions, and in particular whether it holds also in the case where intermetallic compounds are formed. In his present researches (*Zeitschrift für Anorganische Chemie*, vol. xciv., pages 161–193, February, 1916) Ludwik again relies on the cone penetration test, and he introduces a new term, "efficacy," for the convenient interpretation of the results. This efficacy is, for very diluted solutions of equal concentration (by weight), defined as being proportional to the number of atoms of the one constituent (or of the compound formed) in unit volume of the other constituent (the solvent). Ludwik plots the penetration of the loaded cone against this efficacy, the alloys being so far all tested in the quenched condition. A great many alloys of various concentrations were prepared in electric furnaces of the Heraeus or Hanemann (kryptol) types at temperatures up to 1,500 deg. C. The metals investigated are aluminium, antimony, lead, copper, magnesium, zinc and tin, and they were alloyed with one another, and also in some cases with cobalt, nickel, manganese, bismuth, cadmium, and silver; a few ternary alloys of aluminium with copper and silver, and of zinc with aluminium and tin were also examined. The materials used were not chemically pure, but of the highest commercial purity. Some of the alloys changed with time; for instance, alloys of Al–Cu became 15 per cent. harder in four months, whilst alloys of Zn with Cd, Al and Mg, and also of Zn with Al and Sn, became softer by up to 25 per cent. In most of the alloys examined the hardness increased as the efficacy was increased, especially in diluted solutions—the concentration was mostly a few per cent. or a half per cent., but rose sometimes to 10 per cent. and more. Thus it would appear that the hardening effect depends in the first instance upon the number of the atoms of other metal added. But this rule must not be generalised. Evidently other factors have to be considered, and there were many exceptions. The addition of bismuth and tin to other metals, for instance, made these alloys softer than they should be according to the rule just stated, provided that chemical compounds be not formed; magnesium also rendered antimony and aluminium too soft, whilst it yielded zinc alloys of unexpectedly high hardness. That the effects should be complex one might anticipate from the consideration that any foreign constituent of an alloy influences the melting-point. In solid solutions of different concentrations maximum hardness generally goes together with minimum electric conductivity (Kurnakow and Zemczuzny). But hardness does not yet admit of theoretical treatment; if it did, the electronic theory of metals would be on a firmer basis.

* See ENGINEERING, page 86 *ante*.

THE PANAMA CANAL.—The total number of vessels passing from the Atlantic to the Pacific through the Panama Canal in the period for August, 1914, to June, 1916, was 941, while those in the opposite direction numbered 934, the total being 1,875. Of these 43.84 per cent. were British and 37.8 per cent. American.

TRADE AFTER THE WAR.—Another indication that Japan is at one with the Allies, says the *London and China Telegraph*, is the joint meeting which was recently held at Tokyo of the Chambers of Commerce of Japan, attended by the presidents of the Chambers of Commerce of every city in the country, when a resolution was passed unanimously agreeing to support the decisions of the Allies' Economic Conference in Paris as regards measures to be adopted both during and after the war. In commercial circles in Great Britain, France and Russia the feeling is almost unanimous that the recommendations of the Economic Conference should be carried out in their entirety. Our contemporary is glad to note that the traders of Japan have spoken with so decisive a voice on this subject, which is one of the very greatest importance to the future development of the trade of all the Allies.

THE INSTITUTION OF MINING ENGINEERS.—The twenty-seventh annual general meeting of this institution will take place on the 14th and 15th inst., at the Royal Technical College, George-street, Glasgow. The following papers will be read, or taken as read:—(1) "The Permeability of Coal to Air or Gas, and the Solubilities of Different Gases in Coal," by J. Ivon Graham. (2) "The Formation of Water in the Oxidation of Coal," by J. Ivon Graham. (3) "The Form and Structure of the Coalfields of Scotland," by David Ferguson. The following papers, which have already appeared in the Transactions, will be open for discussion:—(a) "The Health of Old Colliers," by J. S. Haldane, M.D., F.R.S. (b) "The Estimation of Moisture in Coal," by T. F. Winmill, B.A., B.Sc. (c) "The Absorption of Oxygen by Coal," Parts VIII and IX, by T. F. Winmill, B.A., B.Sc. (d) "The Atmospheric Oxidation of Pyrites," by T. F. Winmill, B.A., B.Sc. On the second day, Friday, the 15th inst., an excursion is to take place on the River Clyde.

AIRCRAFT INSPECTION AND OUTPUT.

By BRIG.-GENERAL F. G. STONE.*

THE hitherto prevailing conception of any inspection branch has not unnaturally been that the officers thereof are primarily, if not exclusively, concerned with the *quality* of the article which they are called upon to inspect, and this conception is, on the whole, a reasonably safe and correct one for peace time.

But in war time, especially in the time of a war such as we are now waging, this conception of the scope and limitations of inspection requires modification. In the creation of the new armies we have already seen how a new spirit has animated the officers who have been appointed to carry out inspections in every branch of training and administration. Almost without exception these officers have instinctively grasped the true inwardness of the situation, and have set themselves to work to *help* quite as much as to criticise. The inspecting officer, as a rule, realised that what the Army Council required was to make the best possible use of the material at its disposal, in the shortest possible space of time; that it was no use to dwell upon shortcomings and deficiencies without at the same time pointing out the means by which such shortcomings and deficiencies could be minimised or rectified. In respect to training, it was of no use to tell a commander that the troops under his command fell short of perfection in this or that respect—which he, alas, knew too well. But if, in the first instance, the inspecting officer took it for granted that everyone was trying to do his best under circumstances of extraordinary difficulty, and then pointed out to officers, to N.C.Os., and to men where and why they failed, and how they could succeed better by adopting other methods, then an inspection meant, not a sense of general discouragement in respect to shortcomings accompanied by a dangerous loss of confidence, but a clearer view of how improvement could be made more rapidly notwithstanding all the difficulties which had previously appeared almost insurmountable. Inspecting officers who took an intelligent view of their duties on the above lines, and who had the capacity themselves to create as well as to criticise, have been of inestimable value during the difficult period of training the new divisions, and many commanding officers will long remember the help which they got, directly and indirectly, during and after an inspection. Of course there has been occasionally the other type of inspecting officer, whose *rôle*, as understood by himself, was merely to find fault, and as a natural consequence to create nervousness, but this type has been remarkably rare. The inspecting officer whose method was to help commanding officers by no means neglected to report in unmistakable terms upon actual inefficiency, wherever he found it, and the independent and unbiased report of the inspecting officer has been of the greatest value in weeding out unsuitable officers of all ranks, in whatever position they might be found.

This spirit of helpfulness in the inspector has not by any means been confined to inspection by officers on the Inspector-General's Staff, but has been observed in officers of the Quartermaster-General's and Adjutant-General's Staffs equally. Here I may perhaps be permitted to recall how eagerly the inspections of a certain inspector of remounts were looked forward to, and how I have been asked by brigade commanders in respect thereto: "When is ——— coming to see my show again?" It may be asked: "What has all this to do with aircraft inspection and output?" The answer is, that in the inspection of the new army a new departure has been taken; it has been taken almost unconsciously, and has been more in the nature of an evolutionary process or adaptation to new conditions than a definite and conscious radical change of methods. The result has been that inspection, intelligently carried out, has become the partner of

* The writer wishes to express his acknowledgment to Mr. A. E. Berriman, Chief Engineer of the Daimler Company, for converting him to the view that, under certain conditions, inspection and output might advantageously be placed under one and the same responsible head: his arguments were primarily in connection with aircraft engines in war time. After the first shock to his conservative digestion, the writer realised that the idea was less revolutionary than it seemed.

output. I have ventured on these preliminary remarks by way of introduction to the subject-matter proper of this article, with a view to discounting at the outset, to some extent, the very natural effect of the shock which any conservative mind must feel when asked to contemplate such an administrative heresy as the combination of responsibility for inspection and output of aeroplanes in the same department.

In war, output is of extraordinary importance, and so also is quality; but circumstances constantly arise in war which call for very nicely balanced judgment between the certainty of a reduced output and the passing into the Service of designs or workmanship, or even of material, which is not of the best quality. Inspection *per se* holds out for the ideal best; in practice it is pretty certain that ideals are seldom attainable, especially under the pressure of war conditions. The ideal should be aimed at in peace, and may be secured—as witness the French 75 mm. gun; but under war conditions one of the principal factors requisite for securing perfection in design, material and output is absent—that factor is time. But reduction in quality may mean reduction in utility; it may be only in the length of life of a machine, it may be in limitation of its all-round usefulness, it may be in its special value for special purposes, or it may be in its reliability as a flying machine. There is no one in a better position to come to a correct conclusion in such cases than the inspector, for he alone maintains a direct and constant touch with the vital actualities appertaining to both sides of the question, and it is for this reason that it is now suggested that output and quality should be considered as a common interest and responsibility of the Inspection Branch.

But in order to bring this about in a really effective manner it will be necessary to introduce certain reforms which will systematise and co-ordinate the work of the factories in such a manner as to bring them, through the medium of the Inspection Branch, into close touch with the pilots and mechanics in the field.

Close co-operation with the trade could be no doubt best assured by means of a Standing Committee of the Society of British Aircraft Constructors, which should be competent to express the views of the trade on all questions that arise.

But the most important step to be taken is one which has no doubt already received the attention of the Air Board, and that is the establishment of an aircraft engineering department, directly responsible to the Board, which should deal with design, experiment and inspection for the entire air service, i.e., for the Royal Flying Corps, the Royal Naval Flying Service, the Aircraft Factory, and all private factories. This would be the beginning of a single, instead of a dual, control over the supply of machines to the fighting services, and would exercise a most valuable influence on the question of the supply of suitable engines, which is certainly the most burning question at the present moment. An intimate knowledge of the features and performance of all aircraft and their engines should be possessed by this department through the agency of its records branch, and a systematic study of existing data developed. One of their first undertakings should be to review the engines now under construction or development and decide whether they are worthy of being launched into the experimental stage.

If a design is approved for experiment, an experimental contract for not less than fifty units should be given out, so that the machine may be tried on an output basis: engines could, and should, obviously be contracted for separately from aeroplanes or other aircraft, but in no case should any contract of an experimental character be divided between two or more firms or factories. All improvements and alterations should be made on the experimental contract, and as soon as the Inspection Branch is satisfied that a serviceable machine has been incubated, a batch of fifty should be hatched out without further delay, any further improvements which may suggest themselves in the meantime being postponed for execution in the next batch. In other words, the inspector must decide when the moment has arrived for output to take precedence of improvement in quality. A very heavy responsibility must rest upon the Inspection Branch, but by perfecting its organisation there will be no serious difficulty in the way of inspectors discharging their obligations not merely in a manner satisfactory to their own consciences, but in such a manner as to satisfy this great Service for whose benefit they exist.

It would probably be found best to create two divisions of the Inspection Branch:—

(*a*) Inspectors of performances in the field.

(*b*) Inspectors of workmanship.

The former would always be in actual touch with the pilots and mechanics in the field, and would go backwards and forwards between the field and the factory, so as to keep the inspectors of workmanship cognisant of the behaviour of every part of a machine under the stress of service conditions, and would form the direct link between the manufacturer and the user. They would also form a sort of intelligence corps to supply the headquarters in London with first-hand information upon every conceivable point in connection with the aircraft at the front.

The unification of supply under the Air Board, instead of the wasteful plan—one cannot call it a system—of allowing the Navy and the Army to compete against each other in the same markets, should result in an economy of skilled *personnel* which would enable some such system as I have sketched out to be more efficiently performed than would otherwise be the case, without in any way prejudicing the question of the employment of the machines after they have been handed over by the factories, with the approval of the Inspection Branch, for use with either branch of the Service.

Under such a system of inspection as I have proposed, which would make the inspector responsible for output as well as quality, it would not be possible for the flying services to complain that they were in any way inadequately supplied, without being able to fix the responsibility on the right shoulders, and remedying the grievance if it were possible to do so; it would not be possible for the manufacturer to say that he was quite able to do his part of the contract if he were not injudiciously interfered with by the inspector; or for the inspector to say that no machines of a certain class were available, because he had been obliged to condemn a whole batch which did not come up to the specification.

LITERATURE.

The Deposits of the Useful Minerals and Rocks, their Origin, Form and Content. By Professor Dr. F. BEYSCHLAG, Professor I. H. L. VOGT and Professor Dr. P. KRUSCH. Translated by S. J. TRUSCOTT. Vol. II. Macmillan and Co. London: 1916. [Price 20s.]

IN the first volume of this encyclopædic review of the distribution of the mineral deposits, the authors discussed the causes which determine the forms of the different deposits and the various modes of action that have led to the genesis of ore bodies. They then proceeded to the description of typical occurrences in different forms of deposits, and this second volume continues the description of the minerals encountered in lodes, ore-beds, metasomatic and gravel deposits. Here, as in the first volume, they have kept in view the important point that a knowledge of the causes that have controlled formation of mineral deposits is essential to the thorough exploitation of the mineral resources of the world. The book is therefore, happily, both practical and scientific; and emphasises, if there is any need for so obvious a deduction, the desirability of allowing pure and applied geology to be united in a common aim and purpose. This mutual agreement has not always existed. Antagonism has at times divorced the interests of the geologist from those of the mining engineer, leading the one to indulge in pure speculation and the other to mistrust the conclusions of science. The demon of commercialism may still frighten some who would restrict the science to the task of evolving new geological principles. On the other hand, there is a miscalled applied geology that is not science, but a commercial exploitation of natural resources that masquerades under the respectable cloak of scientific geology. The gradually changing conditions of the world, however, demand that increased attention should be given to applied science. A thinly inhabited country can carry on shallow mining operations with little recourse to science or technology, but with denser occupation comes a time when the superficial deposits can no longer yield sufficient minerals and the appeal to rigorous scientific methods becomes urgent and compelling. That stage is now reached in many parts of the globe, and a haphazard, incomplete husbanding of the mineral wealth that satisfied a more primitive age must give way to a systematised harvesting that neglects none of the advice and none of the lessons that accurate observation has placed at the command of the miner. The authors deal adequately both with the scientific and the economic points of view.

It cannot be said with any certainty that the attempts to explain the problem of ore genesis have been exhausted. So many theories have been proposed, and have been supported by recognised authorities and much genuine research, only to become discredited or to be merged into some new hypothesis in which the original suggestion takes a very secondary place. No simple hypothesis can be expected to explain all the observed phenomena, since they are the result of various chemical and mechanical actions, operating within a wide range of pressure and temperature on different agents at different geologic times, and though generalisation has sometimes outrun observed facts, causing theories to be built on too slight a foundation, there is little reason to sneer at the errors of the past or to infer the entire abandonment of the theories that, built on a wider base, are generally accepted. Without some working hypothesis it is impossible to forecast the continuity of an ore-body beyond the limits of the ore in sight, and though the theoretical geologist has sometimes followed a false lead, as in the case of Sandberger, who, for prospecting lodes, proposed a chemical method which was put in operation by a Government Commission in Austria without economic result, yet instances are as well known in which the indications of geologists have proved well founded and consequently beneficial. It is more important to note that certain principles of ore deposit and ore enrichment are firmly established, and the existence of such a book as the authors have been able to compile shows how well and searching has been the collection of facts and the extent to which it has been possible to classify them.

In this volume, at least, the authors are not greatly concerned with hypotheses. They put before the reader in a succinct form the main lines of conjecture and deduction that have been accepted since Werner taught that all lodes were due to the filling of contraction fissures from above, the vein minerals being deposited by chemical precipitation. The correctness of the descensionist theory has been demonstrated in isolated cases, and the general impoverishment and disappearance of the lodes in depth furnish a feeble measure of support. When new facts demonstrated the untenable character of the descensionist view, the Plutonists had an innings, ascribing all ore deposits and ore veins to an igneous eruptive origin, urging that the materials which fill the mineral veins were melted by the internal heat of the earth and forcibly injected into the clefts and fissures of the strata. To this school of ascensionists succeeded a third, the supporters of a process of lateral secretion, who maintained that the mineral contents were leached from the country rock and carried laterally to the fissure in which they are deposited. Ingenuity can hardly carry the transportation theories further. In three-dimensional space the directions of motion are limited, and in future we must content ourselves with modifications and combinations of the upward, downward, and lateral motion. The migration of the constituents may be effected over longer or shorter distances, or lateral secretions can be combined with ascensional movement, as Van Hise has advocated. Vogt, one of the joint authors of this book, has proposed a pneumatolytic theory, in which certain active agents, as fluorine, chlorine, sulphur, phosphorus, &c., form volatile compounds with metals which escape as gases with low critical temperatures from the granite magma, and ascend through fissures or force a passage through the overlying rocks.

It is certainly not easy to form a correct mental

picture of the complex processes that geologists suggest have resulted in the collection and distribution of minerals, and our most settled convictions are liable to be confused by later information. New occurrences will overthrow the most plausible hypotheses and demand a special mechanism to provide a satisfactory explanation. In the present state of our knowledge the most judicious plan is that adopted by the authors, of grouping, as far as possible, the deposits of the several minerals according to the agent or process that has determined the form in which they are found. If, as an example, gold is selected, one of the ores whose distribution is discussed at length in this volume, we shall find it in combination with silver, copper, lead, &c., in tertiary and cretaceous eruptives, under conditions that suggest that the deposition of the ore and gangue of these loads was due to the action of heated waters closely associated with actual eruption. The waters were present in considerable volume, from which it may be inferred that the metals were in a state of minute subdivision. There is evidence of the action of sulphuretted hydrogen and of carbonic dioxide, while silica and iron appear to have been absent. Such conditions obtain very generally in the young gold-silver lodes, and, if pursued still further, it will be found that these lodes occur chiefly in volcanic vents, are characterised by an intense metamorphism of the rock, and do not penetrate far below the surface. As a rule, about 500 metres is the limit of payable depth. Essentially different conditions characterise the gold lodes met in Palæozoic beds. In the important matter of depth these latter will not infrequently extend to more than 1,000 metres, and in some of the Californian mines are worked below that level. The width is less than that of the young gold lodes, but the length along the strike is more considerable. The distinguishing feature, however, is the separation of the lode from the country rock, quartz being the most abundant gangue mineral present. Weathering has often freed the lodes from the neighbouring less-resisting rock, and they protrude at the surface as walls, ledges and reefs. Moreover, the gold in these old lodes is pure and not mixed in varying proportion with silver or other metals.

The third most important class of gold deposit is found in ore beds, as represented by the auriferous conglomerate of the Witwatersrand. Here the ore beds lie one above the other, separated by barren material of variable thickness. Some of these conglomerates have resulted from the disintegration of gold lodes, the detritus of which has been subsequently cemented, giving rise to fossil gravels. Under such circumstances gold may be found as nuggets, or in the form of auriferous pyrites, the distribution of the gold varying in vertical section as in horizontal extent, but inasmuch as there is an irregular but noticeable impoverishment with increasing depth, the view has been put forward that the gold of this deposit was precipitated by ascending thermal waters in proportion to the loss of temperature and pressure, certainly a very different mechanism to that operating in the lodes and equally distinct from the metasomatic replacements, another form in which gold is mined. In this last case the fissure veins are not true cavity fillings, but are due to the replacement of the rock material by substances deposited by solutions circulating along fault fissures. In the case of gold, metasomatic processes are due to silicification or impregnation with quartz. At Lydenburg, in the Transvaal, limestone or dolomite has been altered to quartz. These are regarded as the main causes of gold deposits, and it is desirable to treat each class separately. Individual occurrences will still bring sufficient difficulties, as in the case of Mount Morgan in Queensland, whose enrichment and impoverishment can only be explained by the introduction of special agents.

It would be, of course, quite out of place to attempt to follow individual instances. We have endeavoured simply to indicate the general plan adopted by the authors. Recognising the existence of types distinguished by certain features, they have described under those types the lodes, ore-beds, &c., in which the minerals are found. Tin, lead, silver, antimony, iron, copper, manganese and some other minerals of less economic value are all treated on the same plan of general and individual description. The literature quoted shows how thorough and exhaustive has been the research, and with what completeness the German authors have achieved their task. To the commercial world the collected information is as valuable as the discussion is to the scientific. The extent of the mineral production of the world is passed in review, and an attempt is also made to estimate the ore reserves of the future.

The authors have been very fortunate in finding a translator so well equipped for the task at which he has worked with as much success as industry. It is only a little more than a year since the first volume appeared, and only by very close application combined with intimate knowledge of his subject could such a mass of work have been accomplished. A third volume is necessary to complete the treatise, but owing to the severance of relations through the war, it is not known whether the original has been published.

The Thermodynamic Properties of Ammonia, computed for the use of Engineers from new Experimental Data derived from Investigations made at the Massachusetts Institute of Technology. By FREDERICK G. KEYES and ROBERT B. BROWNLEE. New York: John Wiley and Sons; and London: Chapman and Hall, Limited. [Price 4s. 6d. net.]

THE investigation of the properties of saturated and superheated ammonia was carried out, under the direction of Mr. F. G. Keyes, by Messrs. Henry A. Babcock, Harvey S. Benson and Robert B. Brownlee. The difficult computations were made by Mr. George W. Clark, with the aid of a grant from the American Academy. The researches concern the problems of ammonia refrigerators and do not touch the synthetic preparation of ammonia. The large octavo volume of 75 pages before us is essentially theoretical and tabular; a descriptive account is to follow. The only experimental detail mentioned refers to the measurement of the vapour pressure of ammonia. The pressure exerted by the ammonia against a piston was equilibrated by means of weights, and the calibration of the pressure piston was accomplished with a column of mercury, 12.8 m. in height. This mercury tube ended in a closed steel cylinder filled with mercury and oil; the oil communicated with a Cailletet pump, the mercury with a vertical gauge tube, in which the mercury in the lower portion was connected by a capillary section with the oil in the upper portion of the tube. When the weights in the scale pan were insufficient to balance the vapour pressure, the mercury moved upward in the capillary and closed a telephone circuit; thus the equilibrium position of the piston could be determined with a sensitiveness of 0.1 gramme. The method had to allow for a possible leak of oil at the piston itself, which had a diameter of 0.476 cm.; this leak amounted only to 7×10^{-4} cub. cm. per hour per atmosphere, however, and readings could be taken rapidly and accurately. It should be pointed out that the experimental records are in the metric system, but that the tables of the thermodynamic constants of ammonia are expressed in lb., deg. F., British thermal units, &c.; the Mollier diagram added to the volume is also based on the British system of measures.

Table I gives the thermodynamic properties of saturated ammonia with the temperature as the argument; in Table II the pressure is the argument. Table I tabulates the results for every degree F. within the range −100 to + 150 deg. F., and then up to 200 deg. for every 5 deg. Table II similarly records the data for every pound pressure from 5 up to 200 lb.; afterwards the table is continued in pressure steps of 2, 10 and 25 lb. up to 300, 500 and 750-lb. pressure. The superheat, Table III, gives the temperature, the total heat of the liquid, and the vapour volumes and entropies of the liquid and vapour from the saturation pressure up to 400 lb.; this table occupies 20 pages of the volume, the superheat limit being 300 deg. The Mollier chart plots the results of the tables on an oblique system of co-ordinates—to save space—heat contents as ordinates against entropies as abscissæ, marking the curves for constant pressure, constant quality and constant temperature.

The value of the present volume lies in the tables, which will be found convenient for engineers, and in the exposition of the theory and the critical review of previous investigations. The form of the treatment, and especially the equation of state, adopted by Mr. Keyes, differ from those of other investigators; as regards the equation of state the reader is referred to a previous publication. The authors made a great many experiments, but they did not redetermine the Joule-Thomson effect (porous-plug experiment) of ammonia, which would have afforded a valuable check for their equation of state. This effect has, in the case of ammonia, only been determined by Wobsa, whose curve appeared anomalous, possibly because his ammonia contained about 0.5 per cent. of water vapour. Some of the effects produced by small impurities—*e.g.*, a little salt in the boiler water—in thermodynamical calculations have only recently been cleared up; the peculiarly strong absorption of glass for ammonia seems to vitiate some of the curves of so careful a worker as Kamerlingh Onnes. Thus a further check of the formula for the equation of state might be desirable, and as the investigation of liquid ammonia was reopened at Boston, if we are not mistaken, about 15 years ago, by Kraus and Franklin, when studying non-aqueous solvents for electrolytes, the complete solution of this part of the ammonia problems might appropriately be worked out in New England.

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PENNSYLVANIA RAILROAD.—The gross earnings of the Pennsylvania Railroad for the first half of this year were 210,695,049 dols., as compared with 164,779,708 dols. in the first half of 1915, and 170,632,212 dols. in the first half of 1914. The net earnings of the undertaking (after payment of taxes) in the first half of 1916 were 50,767,754 dols., as compared with 28,749,315 dols. and 26,647,225 dols. Other great American railroad companies have issued more or less equally favourable returns.

TREE-FELLING BY MACHINERY.

On July 21 last Messrs. A. Ransome and Co., Limited, of Newark-on-Trent, gave an exhibition of mechanical tree-felling and cross-cutting under the auspices of the Home-Grown Timber Committee, of 4, The Sanctuary, Westminster. The site chosen was in the Ercall Woods, situated about 7 miles from Newport, Salop.

A combined steam tree-felling and cross-cutting machine was employed, and steam was supplied from a 4 n.h.p. Spencer-Hopwood water-tube boiler, and a 120-ft. length of metallic steam hose, covered with felt and canvas, furnished steam at 80 lb. pressure to the tree-feller. A steam hose of this length enables all the trees within an area of 1 acre to be felled without shifting the boiler, provided that this is placed in the centre of the ground to be covered (see illustration). The boiler, which could be easily moved about by one horse, was fired entirely with wood refuse.

It took 4 or 5 minutes to shift the machine from one tree to another and fix it for the next cut, this operation being greatly facilitated by a pair of removable wheels. One great advantage of this machine is that by making a small excavation of about 4 in. to receive it, the trees are felled absolutely on a level with the ground, and the cuts in all instances are perfectly clean. Several large fir trees were felled, and it may be mentioned in this connection that it only took 1 minute 45 seconds actual cutting to fell a fir tree 2 ft. 8 in. in diameter at the butt.

At the conclusion of the tree-felling the machine was, by means of an interchangeable frame, converted in a very few minutes for cross-cutting, and in doing this work it cut the logs into lengths in even less time than it took to fell them.

The machine was worked by two men only who, besides shifting the machine from tree to tree, also stoked the boiler.

PIANO WITH ELECTRICALLY-SUSTAINED NOTES.

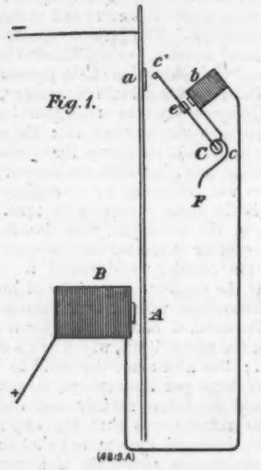
A paper was read in the early part of July, 1914, before the Société des Ingénieurs Civils de France, Paris, on the application of electricity for sustaining the notes, or increasing the sonorousness, of pianos, and a demonstration was made at the same time upon a piano fitted with the electric device in question. This device was invented by Messrs. Maitre and Martin, and the paper was read by Mr. H. Bevierre, a member of the French Society of Civil Engineers, who passed in review the various attempts hitherto made with the same purpose in view. The most successful of these earlier attempts was the combination of a piano with an organ, but the combination was not satisfactory inasmuch as the player could play only with one hand on each; besides this, it was difficult to maintain the two instruments in tune, for upon a rise in temperature the organ rose in tone whilst the piano fell.

The difficulty has been solved by the use of an electric current. In all former attempts in the application of the electric current as a means for keeping piano wires in sustained vibration, an electro-magnet was resorted to, placed in front of the wire and so operated that every half-vibration following upon magnetic attraction was followed by a suitable breaking process of one half-vibration due to the elastic reaction of the wire. In order that the wire should vibrate and give its characteristic note, it is necessary to have breaks and successive makes equal in number to the number of vibrations which are proper to the note considered. Thus, for example, the note C 6 has 4,176 single or half-vibrations per second, and in order to produce it there are required 2,088 makes and as many breaks of current. Moreover, it is necessary that the interrupter be in phase with the vibration of the note considered. Contact has to be established the moment when the wire enters its position of equilibrium and to cease the moment when it returns to it. Any lag or lead in the exciting has a bad influence on the sonorousness of the wire and irregularities may lead to the extinction of the sound.

In order to regulate the rhythm of the interruption, the well-known device used in the trembling bell was first adopted, but the necessity of maintaining complete the sonority of the wires, coupled with the smallness of the vibrations near the ends, led to the use of contacts so delicate that sparks on breaking and mechanical deformations entailed constant irregularities. An auxiliary vibrator was resorted to later, this being a kind of tuning-fork synchronised with the wire to be struck, but it was difficult to obtain perfect harmony and the working was found so irregular that the device was abandoned. From 1888 to 1894, Dr. Eisenmann, Berlin, endeavoured to use as interrupters microphones arranged on the sounding-board, and devised the electrophonic piano, but this having been long since forgotten cannot have been a success. The reason is that the phase of the sounding-board is not exactly that of the wire. The electrophonic piano had four microphones only, and whilst the interruption of each suited certain notes, it did not suit others. Moreover, it would appear difficult to obtain accurately with a microphone the theoretic break corresponding to each note.

It was necessary, therefore, to consider individual interruption by the wire itself and to discover contacts, not liable to get out of order and in constant synchronism with the wire. Messrs. Maitre and Martin took up the problem on these lines and their device formed the subject of the paper we refer to. It is illustrated in the diagrams above. Fig. 1 shows the arrangement they have selected for vibrating one wire. In this diagram A is the wire; B the electro-magnet which operates it, styled the main electro-magnet; b is an auxiliary exciting electro-magnet which operates the movable arm C of a contact piece c_1 which pivots round the point c and forms with the vibrating wire a circuit interrupter; F is a return spring which constantly tends to bring it back on the vibrating body. The two electro-magnets are in the same circuit. The current follows the path B, b, c, C, c_1, A, and flows back to its source. When the circuit is closed, the electro-magnet B attracts the wire and the other electro-magnet b attracts the armature e of the movable arm C and interrupts the current between this and the wire. The armature is then suddenly released, the wire vibrates. Under the action of the return spring contact takes place afresh between c^1 and a and the wire is acted upon afresh, and so on.

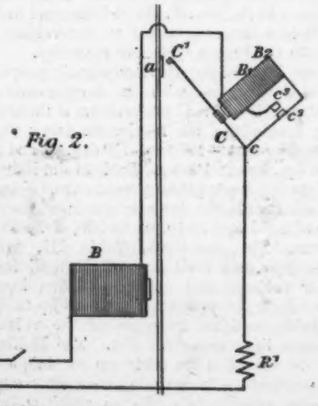
Fig. 1.



Experience having shown that in order to produce instantaneously a pure sound and to maintain it pure during the whole time the current flows through, it is necessary to reduce in the greatest possible measure the amplitude of oscillation of the contact piece, this latter has been provided with a special braking device, the effect of which is to neutralise the oscillatory motions proper which the movable arm C might take by inertia, motions which might have a bad influence upon the regularity of the interruptions.

Reverting to Fig. 1, the action of the movable arm being damped, the wire by its successive oscillations becomes instantaneously, so to speak, the sole agent making for interruptions. From this moment, the interruptions follow each other with such rapidity that the attraction of the armature by the auxiliary electro-magnet is constantly dominated by the reaction of the return spring; the armature becomes inert, the wire is auto-exciting. In other words, the contact piece is rendered movable to insure the first interruptions and becomes fixed spontaneously immediately afterwards. Experience has proved that contacts having a section of a quarter of a square millimetre allow of playing the organ one hour per day during 10 years; in the electrified piano in question, their section is from 6 to 8 sq. mm.

Fig. 2.



The same paper by Mr. H. Bevierre dealt with the means devised for obtaining at the same time a *pianissimo* effect. This effect following a reduction in the amplitude of oscillations of the wire, is secured by adding a resistance to the circuit, as illustrated in the diagram Fig. 2. In this, a second auxiliary electro-magnet B_2 is added in the circuit to the one B_1; it is wound in the same direction as B_1, and is mounted on the same soft iron core as the latter. The electro-magnet B_2 is so designed that its resistance is sufficient to produce the desired *pianissimo* effect; further, the number of ampere-turns of B_1 and B_2 together, during the *pianissimo*, is practically equal to that of B_1 during the *forte*, so that the activity of the interrupting electro-magnet is the same in both cases. During the *pianissimo*, the contacts c_2 and c_3 are separated and B_2 is in the circuit. During the *forte*, c_2 and c_3 are in contact, and B_2 is short-circuited. A pedal puts into operation the contacts c_2 and c_3 either for the whole keyboard or for half the keyboard. A shunt resistance R_1 does away with the induction current spark.

STEAM-DRIVEN TREE-FELLER.

CONSTRUCTED BY MESSRS. A. RANSOME AND CO., LIMITED, NEWARK-ON-TRENT.

FEATURES OF THE NEW COPPER-SMELTING PLANTS IN ARIZONA.*

By A. G. McGREGOR,† B.S., Warren, Ariz.

DURING the past five years five new copper-smelting plants have been built and put into operation in the State of Arizona. The monthly copper output from these plants averages from 5,000,000 to 18,000,000 lb. Previously, there never was as much activity in copper-smelting plant construction in the same length of time in all the rest of the world. Naturally, in this amount of work, some new problems were met and new features in plant design and equipment developed. Some of these features are described in this paper.

CONCENTRATE HAULING, UNLOADING AND SAMPLING SYSTEM.

(*a*) *Concentrate Car.*—The International Smelting Company has provided at its plant at Miami specially-designed cars for hauling the concentrates from the mills of the Inspiration Copper Company and the Miami Copper Company. The car has a bottom that is readily made tight to hold flotation concentrates and is quickly and cheaply unloaded. Figs. 1, 2 and 3 show views and details of the car.

The main feature of this car is the slot in the bottom throughout its length, which is closed by means of short planks that overlap like shiplap as shown by Fig. 1. At one end of the car an iron gate operated by a screw and hand wheel is provided, which clamps or presses the planks together, making the bottom tight. A removable tapered plug rests vertically over this gate when the loading of the concentrates at the mill commences.

A concentrate unloading pocket (Fig. 4), 180 ft. long, is provided at the smelting plant, which has a conveyor belt running throughout its length underneath the track. To unload a car, the vertical plug at the end of the car is lifted by means of a chain hoist which is supported by a trolley overhead. The gate at the end of the car is opened approximately 18 in. The removal of the plug leaves a hole down through the concentrates. The concentrates are poked through the hole from the top of the car until it is convenient for a man to stand on the bottom and draw one of the slats in the bottom toward the gate end of the car. The concentrates are then raked down with hoes on their natural angle of repose, which is nearly vertical, until the next slat is partly uncovered, when it is pulled toward the gate end of the car. This operation progresses until the opposite end of the car is reached. The slats and the grooves supporting them are then carefully swept off and cleaned with a broom; the gate is screwed back, pressing the slats together, and the plug is lowered into place. The car is then ready to be taken back to the concentrator for another load.

(*b*) *Concentrate Sampler.*—Fig. 5 shows diagrammatically the scheme used for sampling the concentrates. It will be noted that the conveyor from the unloading pocket discharges on to a shuttle conveyor (a tripper on the former conveyor could have been substituted for the shuttle conveyor, but it would not have handled the sticky concentrates as well). Buckets attached at their ends to chain belts are arranged to cut through the stream of concentrates as they are discharged on to the shuttle conveyor. The chains are driven and supported by sprocket wheels. The arrangement is such that at the highest point in their travel the buckets are in an inverted position. At this point they pass under a revolving shaft which has a number of knockers, made of 6-in. belting, attached to it. These knockers slap the bottom

Fig. 1. 6 TON CONCENTRATE CAR

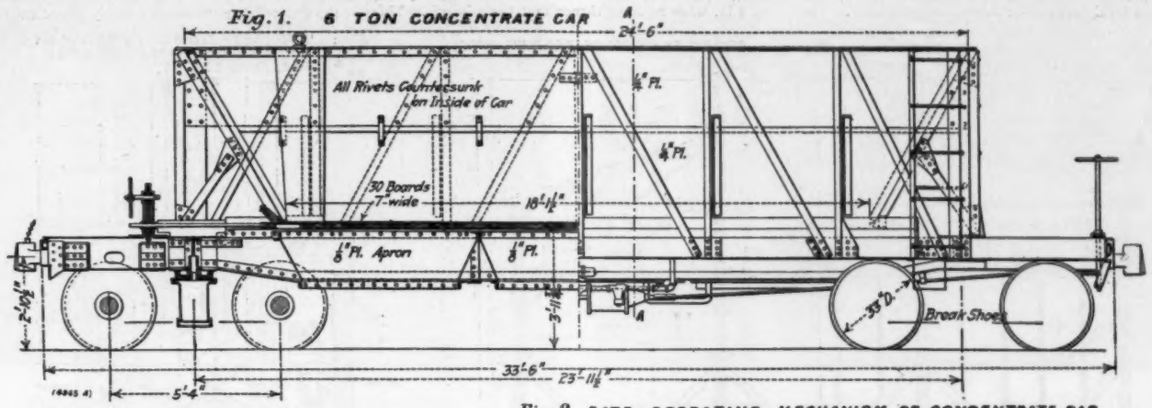


Fig. 2. SECTION A. A. (Fig. 1.)

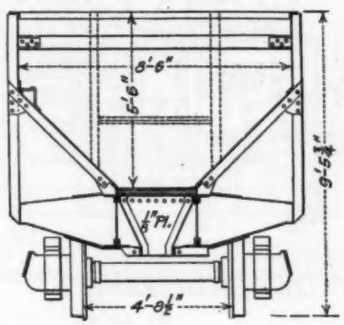


Fig. 3. GATE-OPERATING MECHANISM OF CONCENTRATE CAR

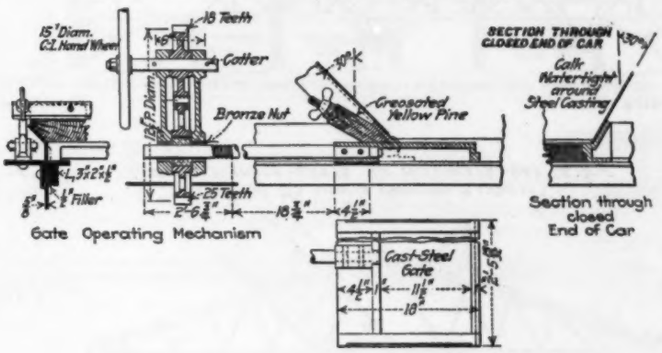


Fig. 4. SECTION THROUGH CONCENTRATE UNLOADING POCKET

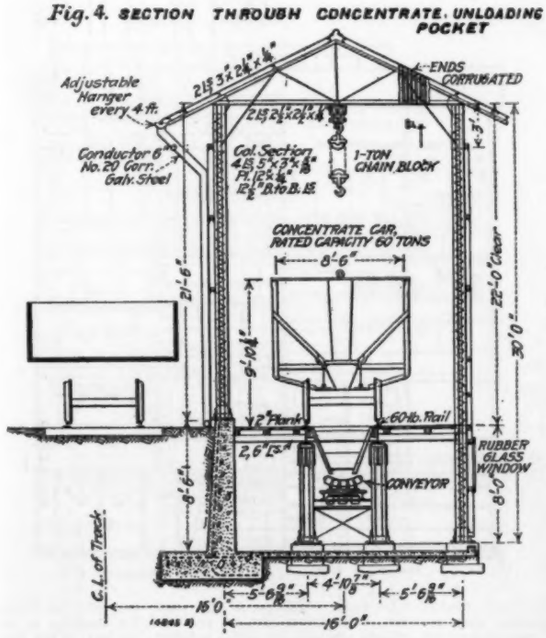
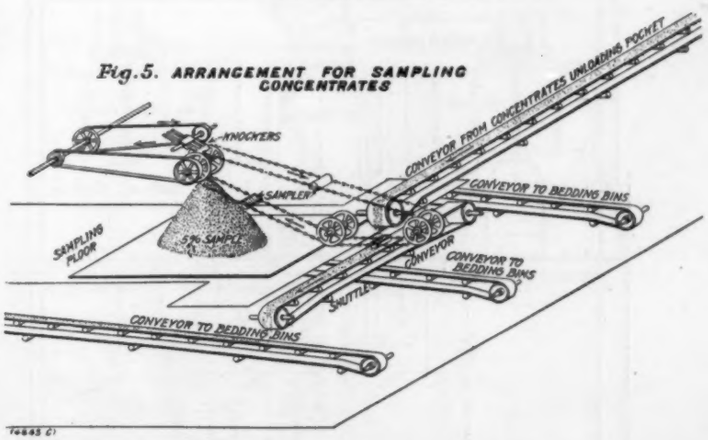


Fig. 5. ARRANGEMENT FOR SAMPLING CONCENTRATES



* Paper read before the American Institute of Mining Engineers.

† Mechanical and Metallurgical Engineer.

of the buckets, jarring loose any concentrates tending to stick to them. This arrangement works satisfactorily on ordinary table and vanner concentrates, but is not satisfactory with flotation concentrates on account of the varying load on the conveyor belt, the flotation concentrates being unloaded from the car in large chunks.

(c) *Bedding Bins.*—Fig. 6 shows a cross-section of the bedding bins used in connection with the concentrate car and sampler just described. The bins are 150 ft. long and have a total capacity of 9,000 tons of charge. The concentrates are delivered by belts from the car-unloading pocket to any one of the three conveyors passing over the bins. Each belt has a motor-operated tripper which travels back and forth throughout the length of the bin. Each tripper is arranged with two cross-belts, which discharge material on both sides of the tripper, instead of the ordinary chutes that would clog with the sticky concentrates. These cross-belts also permit of a wider top on the ore bed than could be obtained with ordinary chutes. The cross-belts of the tripper, as well as the long belts running over the bins and all the other belts handling sticky concentrates, are speeded to 400 ft. per minute, which aids in discharging the sticky material from the belt when it passes over the pulley at its head end or the pulley of the tripper. An oscillating deflector is so arranged that the material passing over the tripper is discharged, first on one of the short cross-belts and then on the other. This is done to provide an even distribution of the material over the top of the beds, making the height of the bed on both sides of the tripper the same. The tripper is reversed at each end of its travel by the reversal of its propelling motor through a magnet-switch control. The bins have "V" bottoms with a slot 2 ft. 4 in. wide running throughout their length. This slot is covered with short planks which are readily removed, and as the reclaiming progresses, they are merely moved back in the slot. The concentrates are raked down with hoes and allowed to discharge, through the opening in the bottom thus provided, on to the conveyor belts underneath. The concentrates are bedded in these bins with a proper amount of limestone and pyrite and the available secondaries, each bin comprising a bed. Storage bins for storing finely crushed lime rock, secondaries, pyrite, &c. are provided and arranged so that the fine material from these bins is delivered by a conveyor and discharged just ahead of the concentrates on to the belts leading up over the bedding bins. The material next to the bedding belts, therefore, consists largely of finely crushed lime rock, which is a further aid in the discharge of the sticky concentrates from these belts.

Fig. 6. CROSS SECTION OF BEDDING BINS

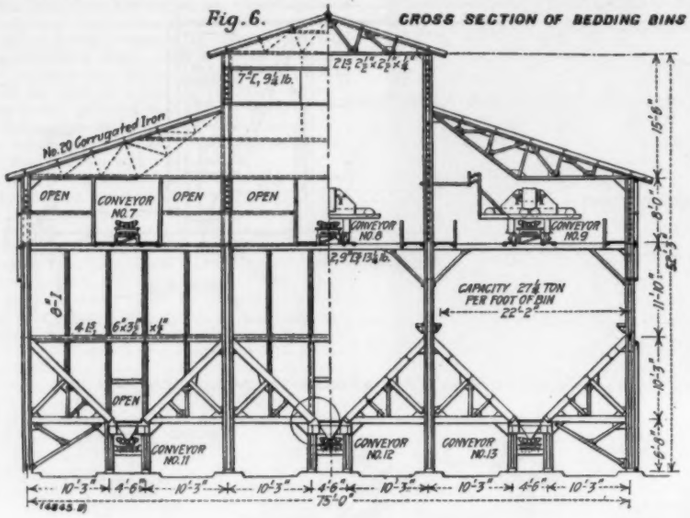


Fig. 7. END ELEVATION OF ROASTER OR DRYER PLANT, INTERNATIONAL SMELTING Co

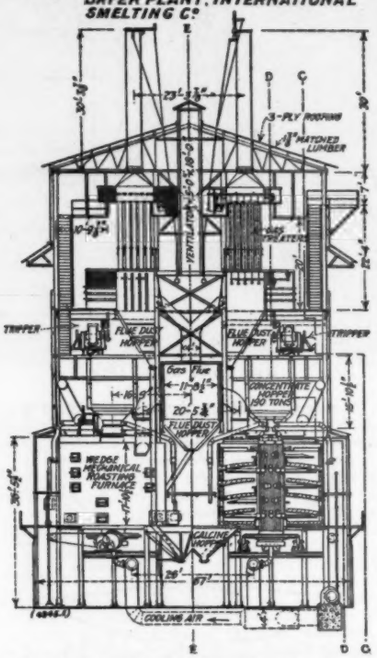


Fig. 8. SIDE ELEVATION OF ROASTER OR DRYER PLANT, INTERNATIONAL SMELTING Co

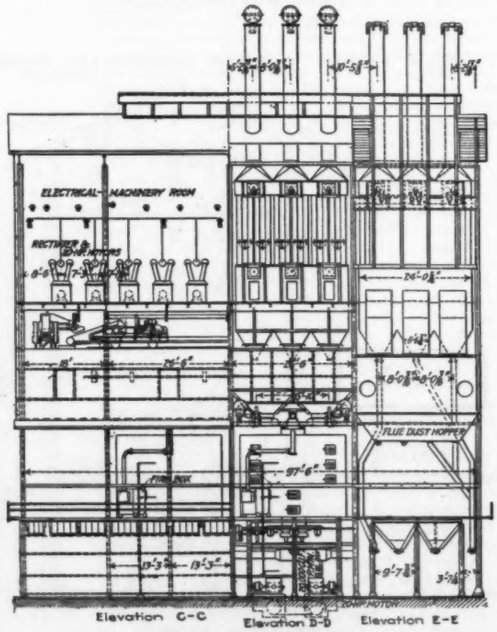
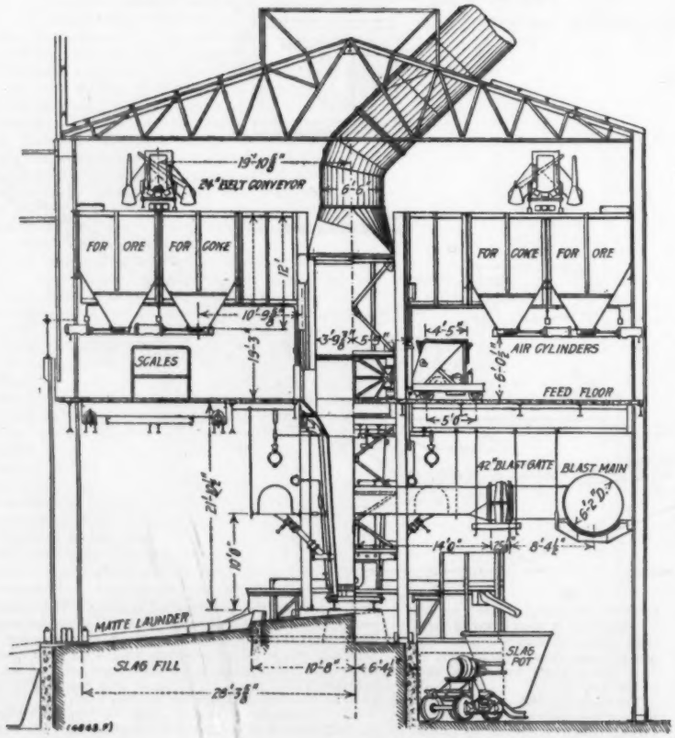


Fig. 9. END ELEVATION OF BLAST-FURNACE PLANT, CALUMET & ARIZONA MINING Co; DOUGALS.



Roaster or Dryer Plant.

Figs. 7 and 8 show end and side elevations respectively of the International Smelting Company's roaster or dryer plant. The main features of this plant consist in the method used for conserving the heat and in the placing of the Cottrell fume treaters directly above the furnaces. The roaster furnaces in this plant are used for drying the concentrates and are not used for roasting, as the charge contains no excess sulphur; in fact, it has been necessary to have some pyrite shipped in from Bisbee in order to raise the sulphur content of the charge sufficiently to prevent the production of mattes too high in copper for good clean slags.

(a) *Conservation of Heat in Furnace.*—The furnaces are air-cooled. The cooling air, after passing through the furnace arms, is conducted up the central shaft to the top, thence down to the oil fire-boxes connecting with the two lower hearths of the furnace. This gives preheated air for the combustion of the oil and conserves the heat

absorbed by the cooling air. To further conserve the heat of the furnace, the linings are 12 in. thick. The outer 4 in. of lining, between hearths, is made of "Nonpareil" insulating brick. The manufacturers of this brick claim that 4 in. of their brick is equivalent in heat insulating value to 40 in. of ordinary brick. The tops of the calcine hoppers of these furnaces are insulated from the lower floor of the furnace building, just above them, by an air space. The calcine hoppers have non-conducting linings consisting of 2½ in. of Nonpareil insulating brick and a 1-in. layer of reinforced concrete. The reinforced concrete is to take the wear and erosion caused by the heated material inside the hopper, as the Nonpareil brick will not stand much wear or rough usage.

(*b*) *Cottrell Dust-collecting System for Furnaces.*—The Cottrell equipment for treating the gases from this plant consists of 12 units of 20 tubes each. The tubes are of lap-welded steel, 13 in. in outside diameter, and 15 ft. in length. They are flanged outward, or "Vanstoned," at each end, which reduces the brush discharge caused by sharp corners and makes a good means of connection to the upper and lower diaphragms. Suitable lugs are welded to the pipes against which the hammers strike when vibrating the tubes to shake off the collected dust. The electrical equipment for this installation is so arranged that the voltage used may be varied from 50,000 to 100,000 volts. The treater tubes were planned for a velocity of 5 ft. per second for the gases passing up through them. The recovery of dust by this treater is practically perfect.

The main feature of this installation is in its arrangement, which permits the gases to pass directly up from the furnaces through the header flue, the tubes and the

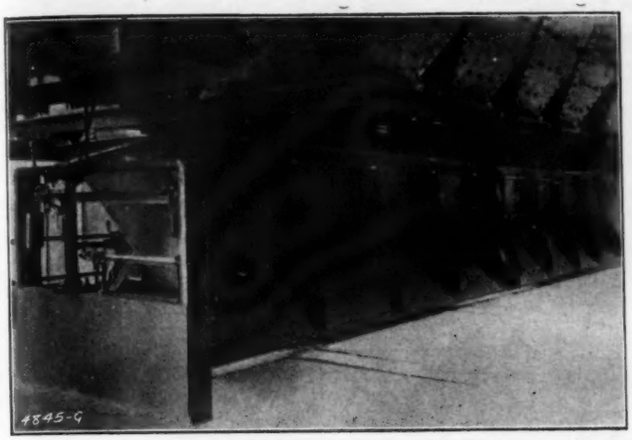


FIG. 10. VIEW SHOWING CHARGE-CAR UNDER BINS.

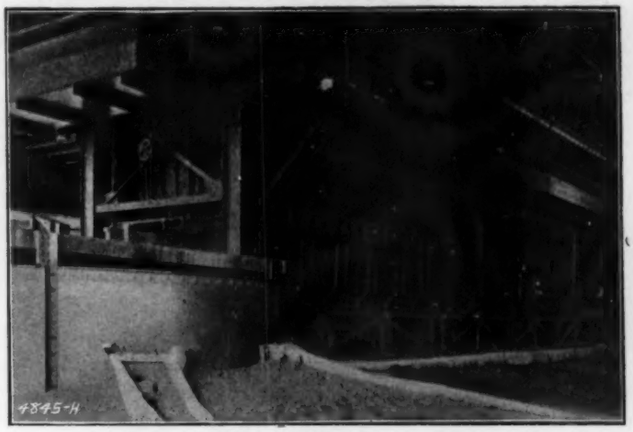


FIG. 11. TUYERES AND BUSTLE-PIPE, BLAST FURNACE OF CALUMET AND ARIZONA MINING COMPANY, DOUGLAS.

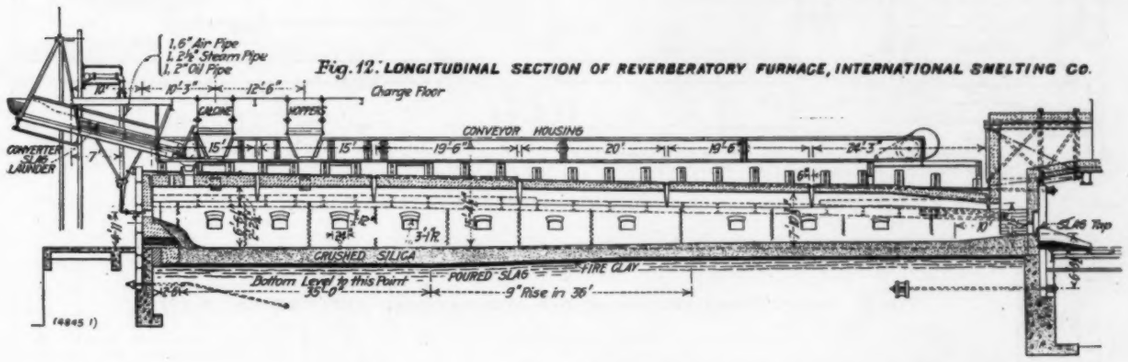
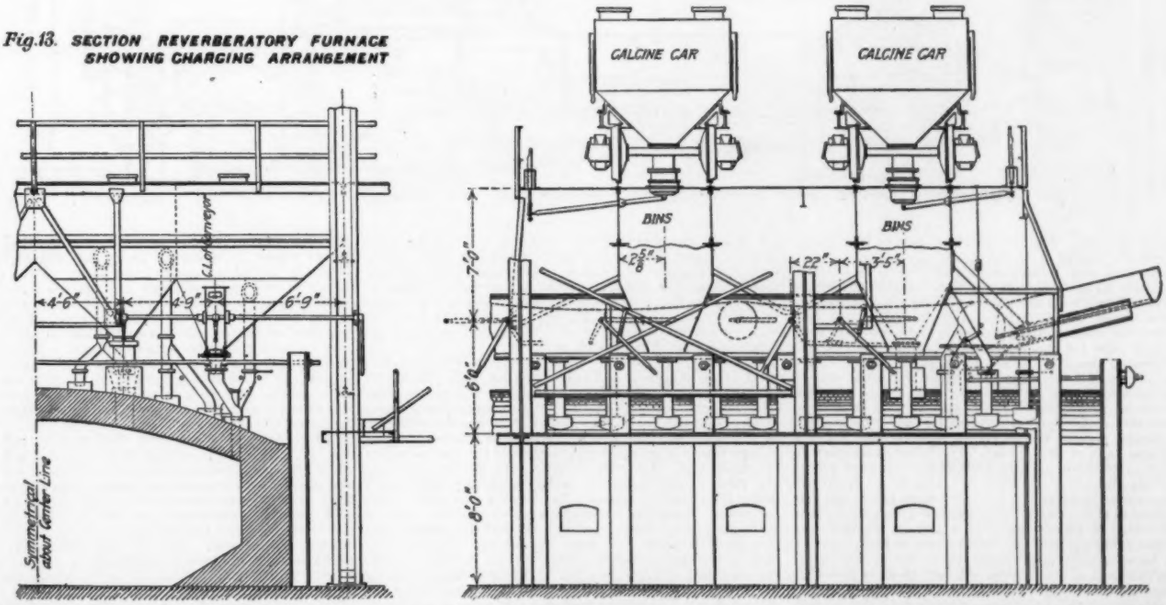


Fig. 12. LONGITUDINAL SECTION OF REVERBERATORY FURNACE, INTERNATIONAL SMELTING CO.

Fig. 14. SIDE ELEVATION OF REVERBERATORY FURNACE SHOWING CHARGING ARRANGEMENT

Fig. 13. SECTION REVERBERATORY FURNACE SHOWING CHARGING ARRANGEMENT



stacks, the gases rising continuously from the furnace hearths to the outlet of the stacks.

BLAST FURNACES.

Fig. 9 shows a general end elevation of the blast furnaces at the Calumet and Arizona Mining Company's plant at Douglas. These furnaces are 40 ft. long by 4 ft. wide at the tuyères. The ores and materials smelted in these furnaces are bedded so that the charge coming to the charge bins over the furnaces is thoroughly mixed. A coke bin and an ore bin are provided on each side of each furnace. Each furnace has four charge cars, two on each side. The cars are 20 ft. long. When receiving a charge of ore or coke, the cars are resting on track scales. Each car has four compartments, and the bins overhead have a gate corresponding to each compartment, so that the amount of charge for any part of the furnace can be regulated to suit the conditions. The car is propelled from the bins to the charging position at the furnace, a distance of 7 ft. or 15 ft. (according to whether a charge of coke or a charge of ore is being moved), by means of an electric motor geared to two wheels of the car. Fig. 10 shows a view of the charge car under the charge bins.

The furnace side jackets are in one length 16 ft. 6 in. long and are 40 in. wide. It will be noted that the bustle pipe is combined with the truss or girder which takes the outward thrust of the jackets at their midpoint. This simplifies the construction and gives more room around the bustle pipe for the water piping, &c. Fig. 11 is a view showing the tuyères and bustle pipe.

The bridge plates for the furnace bottoms are of structural steel; ¼-in. plates are riveted to 6-in. I-beams. The I-beams are spaced 12½ in. apart. The cooling of the bottom is effected entirely by the surrounding air. The I-beams riveted to the plates undoubtedly increase the effectiveness of the cooling. The I-beams supporting the bottom are also used for holding the outward thrust of the bottom ends of the jackets. This thrust is carried into the beams by means of steel rods threaded at one end and flattened at the other. The flattened ends are riveted to the webs of the beams and a nut on the threaded end holds a lug against the bottom end of the jacket.

The furnace tops and charge doors are of structural steel in the form of air jackets. An air space is provided between the inner and outer sheets of the furnace tops. The lower end of this air space connects with the outside air, while the upper end connects with the inside of the furnace top. The cool air is drawn in at the bottom and discharged at the top into the furnace gases going to the chimney, thus insuring a positive air circulation which keeps the sheets of the air top properly cooled. The furnace charge doors are jacketed in a similar manner.

These furnaces have been in use for three years, smelting as high as 1,400 tons of charge each per day, and no repairs or replacements have been made in furnace water-jackets and no warping has taken place in the air-cooled tops.

REVERBERATORY FURNACES.

Fig. 12 shows a side elevation of a typical reverberatory furnace at the International Smelting Company's plant which has several features worthy of mention.

(*a*) *Furnace Bottoms.*—It was especially desirable at this plant, on account of difficulties at another plant, to avoid any trouble with furnace bottoms in starting up. To accomplish this, broken slag, brought in railroad cars from the Old Dominion smelter, was melted in a small blast furnace, obtained by setting up a number of discarded furnace jackets and a motor-driven blower, on the site for the reverberatory furnaces. The molten slag thus obtained was conducted in launders to the foundations of the reverberatory furnaces. Heavy concrete beams and struts were provided between the furnaces for taking the thrust from the lower ends of the buck stays. Later, the spaces between the concrete struts and the beams were filled in with molten slag obtained from the regular operation of the reverberatory furnaces. The slag bottom was covered first with a 4-in. layer of fireclay and then a 27-in. layer of silica (94 per cent. SiO_2) crushed to minus ¼ in. These bottoms gave no trouble whatever in starting up.

(*b*) *Furnace Fettling and Charging System.*—The method of charging, instead of fettling only, along the side walls of reverberatory furnaces, now so successfully used by the Canadian Copper Company and the Anaconda Mining Company, was developed after the construction of this plant was well along. The plant was laid out for charge tracks running at right angles to the furnaces near the firing end. In order to distribute the charge along the sides of the furnaces, charge hoppers were located under the charge tracks directly over the side walls of the furnaces. Drag-chain conveyors were installed, one over each side of each furnace, which received the charge from the charge hoppers (see Figs. 13 and 14). Under these conveyers, approximately every 30 in., suitable down-spouts with gates are provided so that the charge may be distributed along the side walls of the furnaces throughout their length. The bridge wall and side walls at the firing end of the furnaces are charged by drawing directly from the hoppers through suitable spouts.

The floor over the charge tracks around the skimming end of the furnace is paved with firebrick.

(*c*) *Calcine Cars.*—Figs. 15 and 16 show end and side elevations respectively of the calcine car used at the International Smelting Company's plant. The feature of this car is the arrangement used for reducing dust losses in receiving and discharging a charge. The car is equipped with four sliding sleeves in the top which are spaced to register with the discharge openings of the calcine hoppers at the roaster plant. When the car is spotted under the roaster hoppers in its proper position the sleeves are forced up against the calcine hoppers by means of levers on the side of the car. The operating lever is of flat spring steel, so that the sleeve can be firmly pressed into contact with the flange at the bottom of the calcine hopper and held there by a notch in a quadrant on the side of the car. The spring handle insures a good pressure between the sleeve in the top of the car and the flange of the calcine hopper regardless of the small variations in the distance between the top of the car and the calcine hoppers or any lost motion in the connection of the lever with the sleeve. An air vent is provided in the car made of fine woven wire mesh.

Fig. 14 shows the sleeves in the top of the reverberatory furnace charge hoppers for receiving the charge from the calcine car. These sleeves are similar to the sleeves in the top of the calcine car. By pressing down on the lever, which is operated from the charge floor, the sleeve is forced up against the flange of the discharge spout of the car. Notches are provided in the lever which engage a catch and thus hold the sleeves in their upper position while the car is being discharged. The pressure of the handle is transmitted to the sleeve, as will be seen from the figure, through a helical spring, so that a good contact between the sleeve and the spout of the car is assured regardless of the lost motion and wear in the operating levers and the variations in the distance between the sleeves in the charge floor and the flange on the discharge spout of the car.

(*d*) *Baffling in Waste-Heat Boilers.*—By reference to Fig. 17 it will be noted that the header flue between the reverberatory furnaces and the waste-heat boilers and the connections between the header flue and boilers are well up above the furnace floor level, giving ample head room for the convenience and comfort of the workmen; the bottom of the header flue is 10 ft. 6 in. above the furnace floor level. Also it will be noted that the boiler-room floor level corresponds to the furnace floor level. This is made possible by reversing the baffling in the Stirling boilers so that the gases enter the front of the boiler near the top and leave the boiler at the rear near the bottom instead of as in the standard setting.

This arrangement of baffling gives equally as good results from the standpoint of water circulation in the boiler, priming, &c., as the standard baffling.

(To be continued.)

Fig.15. SECTION A.A. END ELEVATION.

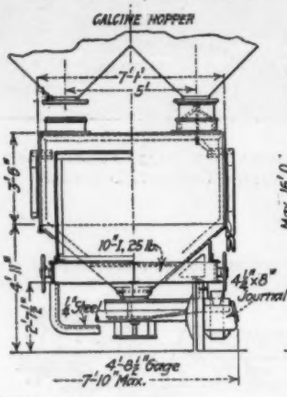


Fig.16. SIDE ELEVATION OF CALCINE CAR

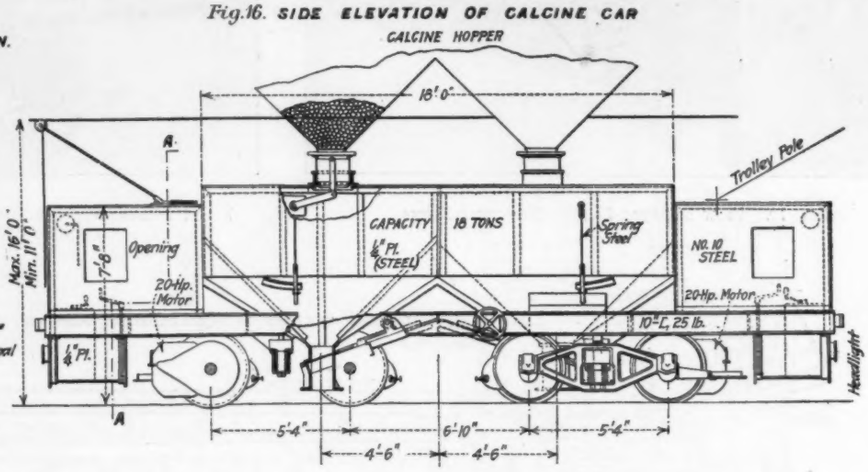
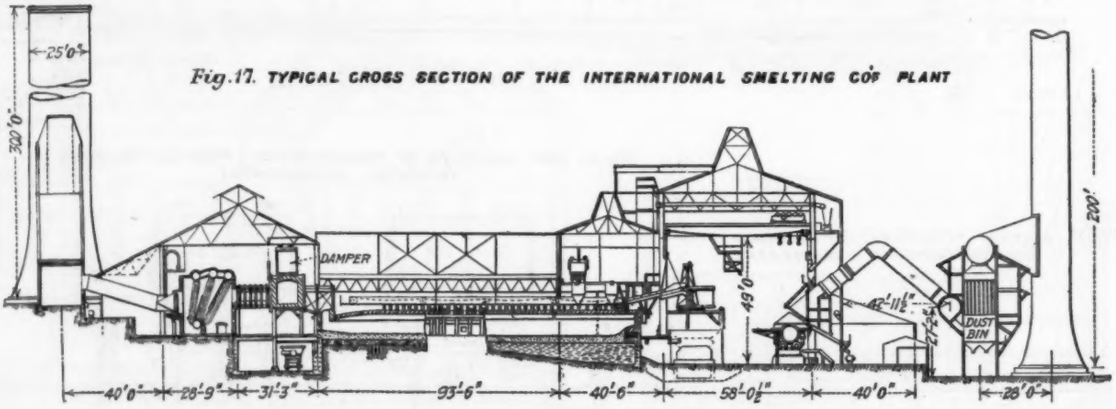


Fig.17. TYPICAL CROSS SECTION OF THE INTERNATIONAL SMELTING CO? PLANT



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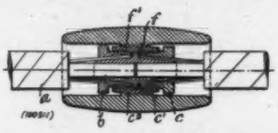
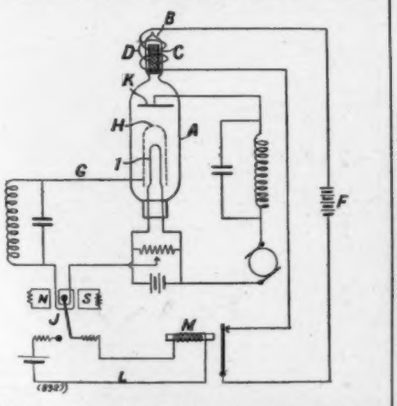
ELECTRICAL APPARATUS.

100,511. A. E. Tanner, Stretford, and E. A. Claremont, High Legh. Electric Cable Joint. (1 *Fig.*) March 20, 1916.—This invention is a modification of the invention described in Specification No. 6,980/15. The invention described in the prior specification comprised an electric joint made by placing a metal sleeve (with or without slits or openings therein) over the ends of the conductors to be joined, allowing molten solder or the like to flow into and around the sleeve and the strands of the conductor, and placing in position an outer sleeve which had no sharp angles or edges and which embraced and lay at a little



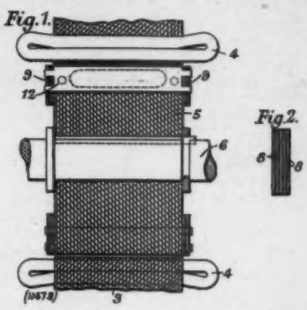
distance from the solid joint of the conductor, or of each of the conductors, and which was in electric connection with and so at the same potential as the ordinary sleeve. According to the present invention, an outer sleeve, such as described in the prior specification, is employed, but such sleeve is in addition to and apart from the device for connecting the sections of the conductor. *a* is the insulated conductor, *b* the bared conductor, *c*, *c*1 and *c*2, respectively, parts of the mechanical connector, *f* the outer sleeve with a threaded part *f*1 to connect with a correspondingly threaded part of the mechanical connector. (*Accepted June* 7, 1916.)

8927/15. Marconi's Wireless Telegraph Company, Limited, and G. M. Wright, London. Wireless Telegraph Receivers. (1 *Fig.*) June 17, 1915.—The applicants have found that it is desirable to be able automatically to regulate the vacuum in a tube containing an anode, a screen and a hot filament as used in wireless telegraph receivers. According to this invention, a tube having a small tube or pocket containing a piece of material which has the property of occluding gas, emitting it when heated, and reabsorbing it as it cools, is provided with a coil which surrounds the pocket and through which a current can be passed so as to heat the material when it is desired to increase the pressure, the current being automatically regulated. A is a vacuous tube having a pocket B containing a pellet C of asbestos and surrounded by a coil D connected to a battery F. Inserted



in the circuit G, containing the screen H and filament I, is a relay J, preferably of the galvanometer type. The anode K is connected up in the usual way to a generator or high-tension battery and the necessary coils. The relay J is adapted to make and break the circuit L of a second relay M, which in turn closes the circuit of the coil D. A current flows in one direction in the circuit G when the vacuum is low, and in the other direction when the vacuum is high, and the tube is most sensitive when the current in the first direction is of a certain strength. Thus, if the backward-flowing current exceeds a certain value, no current passes through the coil D; but if such drops below that value, circuit L is opened and current is supplied to the coil D, heating the pellet and causing the pressure of the gas in the tube A to increase. (*Accepted June* 14, 1916.)

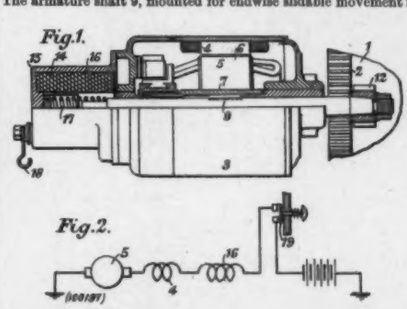
11,473/15. The British Thomson-Houston Company, Limited, London (*General Electric Company, Schenectady, U.S.A.*). **Alternating-Current Motors.** (4 *Figs.*) August 9, 1915.—An induction motor, in accordance with this invention, has a secondary member whose magnetic core is provided with relatively deep slots, in each of which a conductor of considerably less thickness than the slot width is located with adjacent less conductive material for filling the slot. The core 5 is provided with slots of considerable depth. These slots are punched with a width considerably greater than the thickness of the secondary conductor bars; for example, the slots may be punched about ¼ of an inch in width. Each slot carries a composite conductor-bar 12, comprising a sheet-metal strip 7 of high specific conductivity. This sheet-metal strip is of substantially the slot depth, but of considerably less thickness than the slot width. Sheet-metal strips 8 are positioned on each side of the strip 7, and the strips so assembled are securely bound together by spot welding. The sheet-metal strips 8 are of a material of low specific conductivity, and, preferably, are of a magnetic material, such as sheet-iron. The strip 7 will be positioned approximately



in the centre of the slot, and one of the functions of the strips 8 is to fill up the slot. It will be evident that the composite conductor bars provide parallel paths for the secondary current. The copper strips 7 provide a path of relatively low ohmic resistance, while the iron strips 8 provide paths of relatively high ohmic resistance. (*Accepted June* 7, 1916.)

GAS-ENGINES, PRODUCERS, HOLDERS, &c.

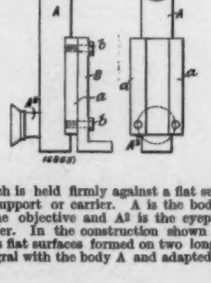
100,197. The British Westinghouse Electric and Manufacturing Company, Limited, London. Internal-Combustion Engines. (2 *Figs.*) March 24, 1915.—In starting mechanisms for internal-combustion engines, according to the present invention, the electric starting motor has an armature shaft which is longitudinally movable relatively to the core structure of the armature and the field magnet frame. The armature shaft is slidably connected to the core structure for rotation therewith, and is actuated longitudinally by an electro-magnet. Because of the small force required to reciprocate the shaft and a pinion that is mounted upon it, the pinion is meshed with a gear wheel that is connected to the engine before the motor armature has acquired such speed that meshing of the gear teeth is rendered difficult. An engine fly-wheel 1 is provided with gear teeth 2. The armature 5 of the electric motor 3 consists of a core structure 6 supported by a spider 7, the hub portion of which is provided with a longitudinally extending bore. The armature shaft 9, mounted for endwise slidable movement in



the bore, is slidably connected to the slider 7. A pinion 12, mounted on the armature shaft 9, coacts with the gear teeth 2 of the fly-wheel 1. The position of the armature shaft 9 relatively to the spider 7 and the stationary parts of the motor is controlled by an electro-magnet 14 that is in series with the motor windings. The inner end portion of the armature shaft 9 constitutes the movable core member of the electro-magnet. To start the engine, the operator closes the switch 19 to complete the motor circuit. Current then flows from the battery through the switch 19, electric motor winding 16, series field winding 4, and the motor armature 5 to earth. The electric motor is energised to actuate the armature shaft 9 and the pinion 12 to the left, as viewed in Fig. 1, against the force of a spring 17. The fly-wheel 1 is then rotated by the motor to crank the engine. When the engine starts under its own power the motor circuit is broken at the switch 19. The electric motor is then de-energised, and the spring 17, which has been compressed, will then return the armature shaft 9 and the pinion 12 to their respective illustrated positions. (*Accepted June* 7, 1916.)

GUNS AND EXPLOSIVES.

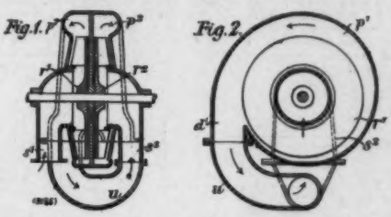
6,863/15. Vickers, Limited, London, and J. Horne, Barrow-in-Furness. Periscopic Sights. (8 *Figs.*) May 7, 1915.—This invention relates to periscopic sights capable of being used with naval ordnance. According to the invention, the body of the optical piece or periscope proper, which is provided with the usual cross-wires or other sighting device, is formed with a



flat surface which is held firmly against a flat surface formed on the periscope support or carrier. A is the body of the optical piece, A^1 is the objective and A^2 is the eyepiece. B is the support or carrier. In the construction shown the body of the optical piece has flat surfaces formed on two longitudinal flanges *a*, *a* made integral with the body A and adapted to beat against the flat surface formed in the contiguous portion of the carrier B, and to be secured in place by screws or bolts *b*, *b* passing through two or more holes formed in the flanges and through similar holes formed in the flat portion of the carrier. (*Accepted June* 14, 1916.)

PUMPS.

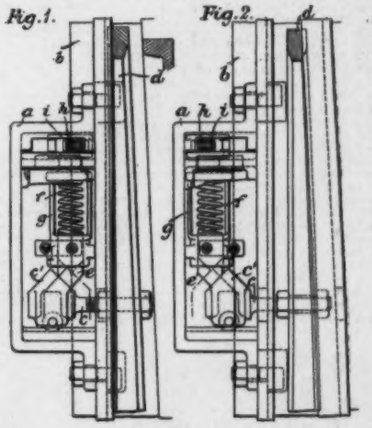
8,156/15. Maschinenfabrik Oerlikon and J. Karrer, Zurich, Switzerland. Multiple-Stage Blower. (8 *Figs.*) June 6, 1914.—The present invention relates to multiple-stage blowers for transporting atmospheric or gaseous media. The invention consists in that each rotor discharges into a spiral or helical casing, whereby extensive deflection is dispensed with, and the effluent velocity acquired is gradually converted into pressure in the course of a long passage; and since each two successive rotors draw in opposite directions, the axial thrust is almost completely neutralised. The medium to be transported

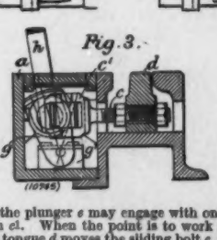


is drawn in through the suction intake *s*1 and delivered by the first rotor *r*1 to the spiral or helical chamber *p*1 in which the effluent velocity is transformed into pressure by uniform deflection. From the delivery outlet *d*1 the medium is conveyed through a connecting piece *u* to the suction intake *s*2 of the second rotor, and thence by the rotor *r*2 into the spiral chamber *p*2, to be then conducted further by a delivery outlet *d*2. The rotors thus draw from opposite sides, in consequence of which the axial thrust is almost completely balanced. By the use of a spiral or helical compression chamber the velocity is transformed into pressure with a minimum of loss. (*Accepted June* 14, 1916.)

RAILWAYS AND TRAMWAYS.

10,745/15. Edgar Allen and Company, Limited, W. E. Robinson, and E. Larmuth, Sheffield. Tramway Points. (9 *Figs.*) July 24, 1915.—This invention relates more particularly to that class of points for tramways, railways and the like which are adapted to be used as automatic points, or as hand-operated points. The invention consists in a cradle, which may either rock about an horizontal axis or slide parallel to itself horizontally and in which is housed a spring-pressed plunger, the nose of which engages with either side of an angular projection on the sliding bolt attached to the tongue of the point, together with means for moving the cradle and plunger to one side or other of the said angular projection on the sliding bolt. The point mechanism is housed in a box *a*, attached to the side of the point body *b*. A sliding bolt *c* attached to the tongue *d* passes through the open side of the box *a*, and through the web of the rail and on one side near its outer end is formed with a projection *c*1, adapted to engage with a spring-pressed plunger *e*. This plunger *e* and spring *f* are housed in a rocking cradle *g*, normally

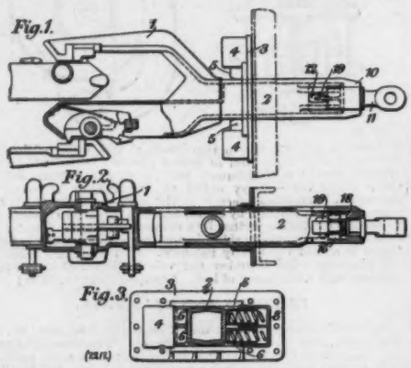




inclined so that the plunger *e* may engage with one side or other of the projection *c*1. When the point is to work automatically, the travel of the tongue *d* moves the sliding bolt *c*, and causes the plunger *e* to rise up on one side of the projection *c*1, but the maximum travel of the tongue is reached before the plunger *e* gets to the summit of the projection *c*1. The tongue *d* is then returned to its normal position by the spring *f*, which causes the sliding bolt *c* to be drawn back. When it is desired that the tongue of the point shall be operated automatically in the direction, for example, to change from the position shown in Fig. 1 to that shown in Fig. 2, the cradle *g* is moved over to its other position by means of a lever *h*, placed in a slot *i*, in the end of the cradle casting. This movement causes the plunger *e* to travel up one side of the projection *c*1, over the summit of same and down the other side, thereby forcing the bolt *c* forward and moving the tongue over in the same manner as previously described. When the point is to be used as a hand-operated one, the requisite movement of the tongue is effected, as in the last-

mentioned case, by means of the lever *h*. The movement of the cradle may, however, be effected through an intermediate lever fitted to the end of the cradle and having its upper end on a level with the roadway, said upper end being provided with a hole to receive the end of an actuating bar or lever. (*Accepted June* 14, 1916.)

7,217/15. J. W. Cloud, London. Automatic Couplings. (3 *Figs.*) May 13, 1915.—This invention is particularly, although not exclusively, adapted for use with vehicles provided with buffers. In the prior application—No. 10,709, 1914—there is described a coupling device for use with railway vehicles, in which each coupling head is constituted by a fork-shaped member, one of the arms of the fork being provided with locking mechanism adapted to occupy more than one locking position and to be moved into these locking positions by the inward movement of the corresponding arm on the other coupling head. According to the present invention, each of such coupling heads is capable of a predetermined amount of rotational movement and of lateral displacement, spring devices being provided for maintaining the coupling heads in efficient relation to each other to effect a coupling operation. Each coupling head comprises a fork-shaped member 1 adapted to be held substantially on the centre

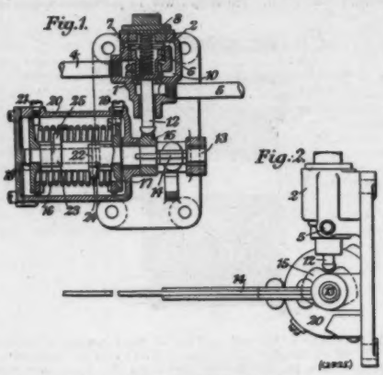


line of the vehicle by means of spring devices 4. Each spring device 4 comprises a pair of movable abutments 5 and 6 arranged one upon the other in the same vertical plane, each abutment 5, 6 being adapted to slide within recesses formed within a casing 8, and interposed between the inner face of each abutment 5, 6 and the wall of the casing 8 are springs. The element 2 of the coupling engages with the end plate 3 of the vehicle frame in such manner as to be capable of a predetermined amount of rotational movement, the disposition of the abutments 5, 6 being such as to permit of such rotational displacement. In order to permit of this rotational movement of the element 2 of the coupling heads, the pivoted member 11 is provided with an extension 12 adapted to project within the interior of the rear end of the element 2, a flange being provided thereon adapted to engage with a recess formed within the rear end of the element 2. The member 12 is provided with a screw-threaded portion with which a nut engages. (*Sealed.*)

10,567/15. Brown Bayley's Steel Works, Limited, and T. H. Sanders, Sheffield. Buffers. (7 *Figs.*) July 21, 1915.—In buffers of the kind in which the box is provided with an internal interrupted recoil collar, and the plunger with corresponding external lugs, an improved form of key is provided which, placed in position from the front of the buffer, is furnished with a self-locking device to secure it in place, and acts also as a guide for the plunger throughout its travel in the box. In combination with this locking guide, means are also provided for enabling the buffer to be assembled away from a press and for neutralising the tendency of the spring to turn the plunger about its axis. Plates 1 and 2 are provided, one for each end of the spring 3. A pin 4 passes through the plate 1, and a pin 5 passes through the plate 2. The pins 4 and 5 are provided with engaging hooks inside the spring 3, the proportion of the parts is such that when the hooks are engaged the spring 3 is pressed slightly more than it is required to be when in its extended position inside the complete buffer. The box 8 is recessed out to form a recoil collar 9 inside its forward part and is provided with grooves 10 extending longitudinally from its forward edge through the recoil collar 9, the plunger 11 being furnished with similar lugs 12 remote from its head 13. A locking guide 15 is provided to fit each of the grooves

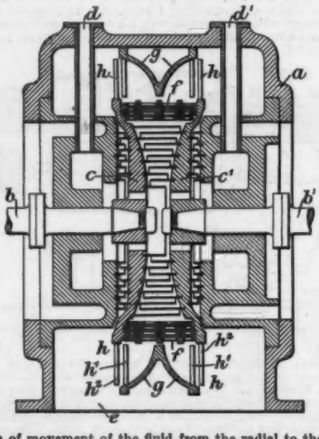
10, and to extend beyond the recoil collar 9. A self-locking device is provided for each of the locking guides 15; they are made of spring steel with one end bent over and adapted to grip the tapered outer side 14 of the box 8. In assembling a buffer, the spring 3, held compressed by the engaging hooks of the pins 4 and 5, is placed in position in the box, and the head and plunger 11 inserted with its lugs 12 entering the grooves 10 inside the box. The locking guides 15 are disposed around the plunger 11, to follow its lugs 12 in their passage along the grooves 10. When the lugs 12 have passed the inner end of the recoil collar 9 the plunger is turned round until its lugs are completely behind the interrupted recoil collar, and the locking guides 15 are now caused to continue their passage along the grooves 10, and are secured in position by hammering their turned-over ends over the lip of the box 8. The buffer will then be completely locked up and ready for use, except that the spring 3 is not exerting any pressure on the plunger 11. The first time, however, that the buffer comes into action or receives a push this is rectified, for the hooks on the pins 4 and 5 are so arranged that they are disengaged automatically as soon as the spring 3 is further compressed to relieve the hooks of the spring pressure. (*Sealed.*)

12,935/15. The Westinghouse Brake Company, Limited, London. Brakes. (6 *Figs.*) May 7, 1915.—This invention relates to valve mechanism adapted to be operated by means of a projection in or near the track for effecting, under predetermined conditions, an application of the brakes. According to this invention, a vent valve 1 is provided connected to a movable abutment 6 normally subjected on both sides to the pressure existing in the vent pipe 4 and held upon its seat by spring pressure, the movement of the abutment to a position corresponding to the open position of the valve being arranged to establish communication between both sides of the valve and the atmosphere, and to thus maintain the valve in its open position for a predetermined length of time. (*Sealed.*)



STEAM-ENGINES, BOILERS, EVAPORATORS &c.

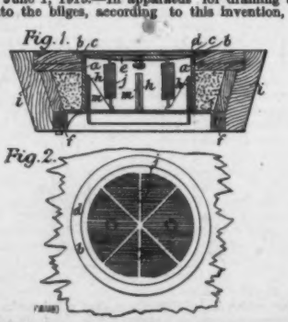
100,484. Svenska Turbinfabriks Aktiebolaget Ljungstrom, Finspong, Sweden. Radial-Flow Turbines. (1 *Fig.*) May 15, 1915.—According to this invention, radially extending blades with corresponding stationary guide-blades are provided outside the series of axially extending blades. These radial blades may consist of one series or ring of guide blades and one series of moving blades. *a* designates the turbine casing, *b*, *b*1 the two turbine shafts, and *c*, *c*1 the two turbine discs mounted on the shafts and rotatable in opposite directions. *d*, *d*1 indicate the driving fluid inlets, and *e* the outlet for the fluid; *f* indicates the outer blade rings of the axial blade system outside which curved plates *g* are positioned, which reverse the



direction of movement of the fluid from the radial to the axial. Before the fluid is admitted into the space enclosed by the turbine casing and in communication with the outlet, it is forced to pass a radial blade system *h*, which consists only of one guide-blade ring *h*1 and one moving blade ring *h*2. By this means it is possible to attain a very complete use of the fluid in the extreme blade rings, which, in radial turbines having only axially-directed moving blades and guide blades, causes trouble owing to the great length of the outer blades and the heavy centrifugal strains which consequently arise. By placing the blades of the extreme outer ring or rings radially, it is possible to make these blades of the necessary length without difficulty. (*Accepted June* 7, 1916.)

SHIPS AND NAUTICAL APPLIANCES.

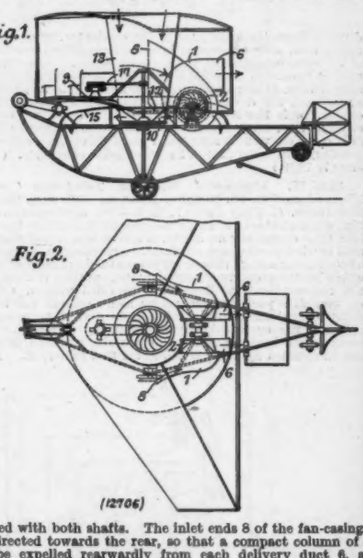
8,115/15. J. E. Wimshurst, London, and J. Stone and Company, Limited, Deptford. Draining Ships' Holds. (8 *Figs.*) June 1, 1915.—In apparatus for draining the holds of ships into the bilges, according to this invention, a casing



having a grating is provided with a floating piston valve mounted in such a manner as to be directly affected and opened by the weight of water above it and passing into the casing from the hold. The valve is closed by a spring or weight or by gravity when no appreciable amount of water is present in the hold, so that any water passing from the hold to the bilges may be dealt with, in known manner, by the bilge pumps, while no appreciable amount of either water or air may penetrate the hold from the bilges, and the necessary insulation of the hold from the bilges is obtained. The valve casing *a* is flush with the floor, is of cylindrical cross-section, and is provided at the top with a recess *c*, for receiving the grating *d*. The valve is normally supported at a suitable distance below the grating *d*, and near the bottom of the casing, so that if any water enters the hold from above the bilges, there may be a sufficient depth and weight of water on the valve to open the latter before there is any appreciable depth of water in the hold. The valve may be a downwardly flanged disc formed at the periphery with a number of equidistant guides *k* to cause it to move axially and without tilting in the casing *a* and is suspended by springs *j* hooked into the grating *d* and into webs *m* supporting the guides *k*. When water passes through the grating *d* it will increase the load on the top of the valve *g* and open it against the action of the springs *j*. As the valve *g* is normally situated at the bottom of the casing *a*, and is guided so as to prevent it from being tilted, it follows that a small amount of movement in the downward direction will have the effect of almost immediately causing a relatively large cross-sectional area of opening and the consequent free passage for water from the hold to the bilges. (*Accepted June* 7, 1916.)

MISCELLANEOUS.

12,706/15. J. Keith, London. Aeroplanes. (8 *Figs.*) Sept. 4, 1915.—This invention consists in providing aeroplanes, hydro-aeroplanes, airships and the like with means in substitution for, or auxiliary to, the propelling devices at present in use, such means being adapted for the production of a rearwardly-directed column of air moving in volume and at high velocity, and being substantially free from eddies. For steering purposes such column of air may be sub-divided into two streams, so that by variation of one stream or the other the craft may be turned round as if supported on a vertical pivot. Two fans of the multi-vane tapered-blade type are mounted between the upper and lower planes of the aeroplane, said fans comprising volute casings 1 containing the fan-runners 2. The shafts of the fan-runners 2 are driven in opposite directions by separate engines located between the delivery ducts 6 of the fan-casings 1. In order to provide for the contingency of a breakdown of one of the engines, the latter are preferably so arranged that either engine may be



coupled with both shafts. The inlet ends 8 of the fan-casings 1 are directed towards the rear, so that a compact column of air will be expelled rearwardly from each delivery duct 6, and consequently the aeroplane will be propelled forwardly by reaction, it being also possible to effect steering of the aeroplane by temporary retardation or acceleration of one or the other of the runners. Further, there is arranged beneath the lower plane 9 an open fan 10 of the multi-vane tapered blade type. The open upper side of the fan-runner 10 adjoins the lower orifice 12 of a duct 13, preferably of downwardly tapering formation and passing through both planes of the aeroplane. The fan-runner 10 is arranged within a deflector 15, serving to deflect downwardly the air which is drawn through the duct 13 and expelled at the periphery of the fan runner 10, the reaction of the downwardly-directed flow of air serving to facilitate the ascent of the aeroplane or to check its descent. The shaft of the fan-runner 10 is driven from an engine located within a chamber 17 forming part of the duct 13, so that efficient cooling of the engine is ensured. (*Sealed.*)

AMERICAN OPINION ON THE RUSSO-JAPANESE COMMERCIAL TREATY.—The announcement of the Treaty negotiated between Russia and Japan has aroused considerable interest and discussion, both in official and in newspaper circles in Washington, states the *London and China Telegraph*. Senator James Hamilton Lewis, speaking in support of his resolution requesting the Secretary of State to submit a report to the Senate on the effect of the Treaty upon American commercial interests in Asia, said:—"It seems to me that if the United States sits silently and allows these contracts to be entered into without any assertion on our part of what we believe to be our rights of trade and the rights of the people of the territory of Asia, other countries will have a right to say that as we sat silent and made no protest it was equivalent to a tacit consent. We may go out of the Philippines or we may not. As long as we are in the Orient we are a part of that civilisation to some extent. Any arrangement that looks to the exclusion of the United States from the enjoyment of full and complete trade relations in Asia should attract our attention. Before such an arrangement is finally consummated the United States should make its interests known, and assert its welfare."